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AN ANNOTATED LIST OF THE FISHES OF LAKE TEXOMA, OKLAHOMA AND TEXAS

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ABSTRACT. During 10 years of collecting with several kinds of gear, 71 species have been collected from the main body, headwaters, tailwaters and inundated tributaries of Lake Texoma. Annotations on ecology, reproduction and abundance are included.

The collections which provide the data for this paper were made, essentially by the authors, over a ten-year period—September, 1948 to September, 1958. Data from collections made by George A. Moore, Virgil E. Dowell, and the Oklahoma Fishery Research Laboratory are also included. Only occasionally have we, the authors, collected together. Riggs' collecting has been confined almost entirely to the Oklahoma side of Lake Texoma and to both sides of its tail waters, with intensive collecting in the vicinity of the University of Oklahoma Biological Station and immediately below the Denison Dam which impounds the lake. Bonn has collected in almost all parts of the lake, its headwaters, and its tail waters, but has concentrated on the Texas side. Collecting by Bonn since 1953 has been part of a program of Federal Aid to Fish Restoration (Dingell-Johnson Project Number Texas F8R). Specimens of all species listed are in the collections of the University of Oklahoma Museum, Zoology Division, the Texas Game and Fish Commission, or the University of Texas, Department of Zoology.

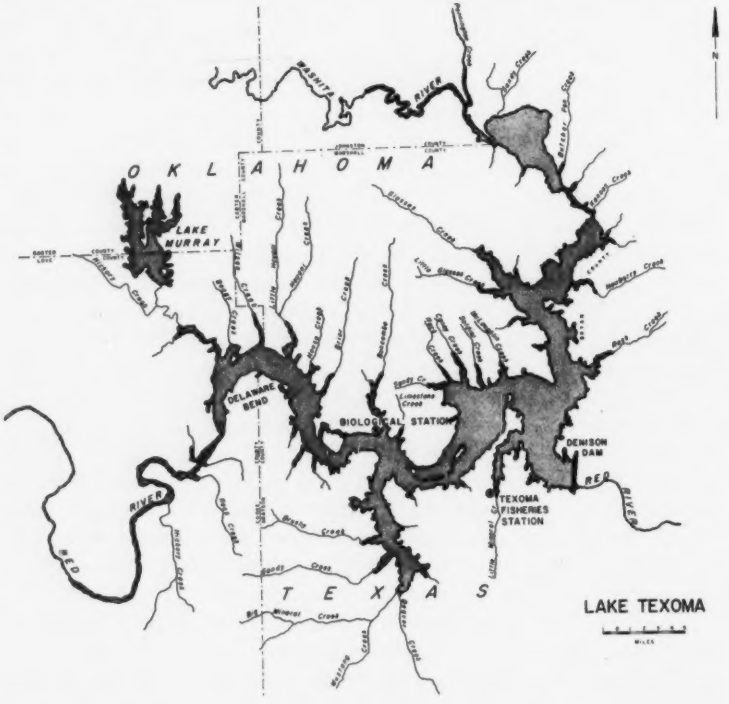
The waters in which the collections were made include: (1) the main body of Lake Texoma; (2) the tail waters and their tributaries from the Denison Dam downstream for a distance of one-half mile; (3) the headwaters upstream in the Red and Washita rivers to the 620-foot contour line; and (4) all tributaries of the lake and its headwaters as far upstream as the upper limits of inundation.

The collections were made by various methods. Most of the larger specimens, one foot or more in length, were taken in gill nets. Hoop nets, trammel nets, large seines, trotlines, electric shockers, and rote-

none also were used to take large fish. The last two methods mentioned also took many small specimens. Most of the small specimens were collected with seines ranging from 3 by 3-foot seines made of plastic screen to a 25-foot bag seine with ¼-inch mesh. The plastic screen seines were used to collect fry and young-of-year.

We do not consider this to be a definitive list since the fish fauna of Lake Texoma has changed too often during the 15 years of its existence. Other species will get into the lake, probably some of those now listed as present will disappear (possibly one or two are already gone from the lake), and certainly the relative abundance of the various species present will constantly change (explained in greater detail in the annotations) in ways similar to the changes of the past 15 years.

Lake Texoma (Fig. 1), an impoundment of the Red and Washita rivers, was filled in 1944. The Denison Dam, which impounds it, is just downstream from the confluence of the two streams, and the lake extends into Bryan, Johnston, Marshall, and Love counties, Oklahoma, and Grayson and Cooke counties, Texas. It was built for hydro-electric



power generation and for flood control, and because of these functions its level fluctuates continuously. The normal or "power pool" level is 617 feet above sea level, but it has been as high as 643 feet, and as low as 599 feet. Normally, the level varies seasonally from about 610 feet in late winter to 622 feet in early June. The surface area at normal level is 93,085 acres; this, of course, fluctuates with the water level.

Many other environmental conditions are constantly changing. Although the water is usually clear, especially in the areas near the dam, spring floods bring high turbidity. This usually settles quickly or flows out with the discharged water. Current, temperature, salinity, hardness, oxygen content, etc., also vary. There is considerable variation in annual rainfall, but it averages about 38 inches. Because of the extensive surface, and the strong winds that frequently blow, particularly from the south, wave action on Lake Texoma is common and often severe.

Apparently, permanent beds of aquatic plants will never become established, but several species, including *Chara* sp., *Potamogeton nodosus*, *P. pectinatus*, *P. crispus*, *Polygonum lapathifolium* and *Eleocharis* sp. become temporarily established, often over extensive areas, as the turbidity and water level fluctuations permit. *Tamarix gallica* and *Salix niger* are often abundant along gently sloping shores, but these too are periodically killed by high water.

The lake basin was cleared before impoundment and practically all trees were cut one to two feet above the ground. Most of the stumps remain, but in the zone of most frequent water level fluctuation wave action has eroded away the soil, thus exposing the roots of the stumps. These exposed stumps are soon knocked down by the pounding waves. The erosion of the shoreline by the waves has changed the bottom of much of the littoral zone of the lake. In many areas sand has replaced topsoil, silt, or clay. The finer materials have been carried out to the depths of the lake, often covering the sand of the old river bed. Bed rock has been uncovered in many places along the shore. The bottom is chiefly silt, clay, or sand, or a mixture of these. The Oklahoma Planning and Resources Board (1953), the U. S. Army Corps of Engineers (1948), and the U. S. Department of the Interior (1943) give more complete data on Lake Texoma.

ANNOTATED LIST OF FISHES

Polyodontidae—Paddlefish

1. *Polyodon spathula*, paddlefish. One large specimen was caught by a commercial fisherman in the upper part of the Red River arm

of the lake in December, 1950; taken regularly in the tail waters by fishermen.

ACIPENSERIDAE—Sturgeons

2. *Scaphirhynchus platorynchus*, shovelnose sturgeon. Unknown from the lake, but occasionally seen and caught in the tail waters; there are also recent records from the Red River above the lake (Riggs and Moore, 1951; Bonn and Kemp, 1952).

LEPISOSTEIDAE—Gars

3. *Lepisosteus spatula*, alligator gar. Large specimens weighing 40 to 125 pounds were taken frequently by commercial fishermen in the middle and upper parts of the Red River arm through 1954. Since that time only a few are taken each year. No young are known to have been taken in the lake.
4. *Lepisosteus platostomus*, shortnose gar. Abundant in shallow water (12 feet or less) along the gently sloping shores in all parts of the lake, and in the moderate current of the tail waters.
5. *Lepisosteus productus*, spotted gar. Most abundant in the upper regions of the inundated portions of clear tributaries, the downstream third of the lake, and the quiet parts of the tail waters. Not as abundant as the shortnose and longnose gars.
6. *Lepisosteus osseus*, longnose gar. The most abundant species of gar in Texoma (apparently present in ratios of about 3 to 1 shortnose gar and 7 to 1 spotted gar); found in shallow water throughout the lake, especially the upper two-thirds of both arms, and in the tail waters. All of these common species of gar are known to spawn in shallow bays and tributaries. In the winter they apparently move to deep water and become inactive, since they are very rarely caught or seen.

HIODONTIDAE—Mooneyes

7. *Hiodon alosoides*, goldeye. Abundant in open water in the clearer parts of the lake and in the tail waters, although its abundance has decreased during the past three years. It is usually taken near the surface; young-of-year are rare.

CLUPEIDAE—Herrings and Shad

8. *Alosa chrysochloris*, skipjack herring. Adults taken regularly by anglers in the tail waters in the spring.
9. *Dorosoma cepedianum*, gizzard shad. The most abundant species

in Texoma and its tail waters. Juveniles and adults commonly taken throughout the lake down to a depth of 40 feet; great schools of young-of-year frequent shallow water or roam through most parts of the lake just beneath the surface.

10. *Dorosoma petenense*, threadfin. This species was first collected in the lake in 1957 (Riggs and Moore, 1958), although it had been known from the tail waters for several years. In 1957 the young-of-year apparently outnumbered young-of-year gizzard shad. Collections in 1958 made with both seines and rotenone indicate fewer fish, but the species is still abundant. Its habits are quite similar to those of the gizzard shad.

Characidae—Characins

11. *Astyanax fasciatus*, banded tetra. This species was first collected in Texoma in 1952 (Riggs, 1954). Riggs and Dowell (1956) collected 33 specimens in several parts of the lake, and Dowell and Riggs (1958) reported collecting 9 *Astyanax* in June, 1955 including specimens as small as 19 mm. They interpreted this as indicating that the species had spawned in the lake. All specimens were collected in shallow water near the shore; most of them from tributaries. Riggs collected seven adults from the small tributary of the tail waters. This fish is sold by Texas bait dealers as "tuna shiners" or "Mexican jumping shiners".

Catostomidae—Suckers

12. *Ictiobus cyprinellus*, bigmouth buffalo. Large individuals commonly taken by commercial fishermen in the upstream halves of both arms at all depths down to about 30 feet; fairly common in the tailwaters. This fish has the greatest commercial value of any species in Texoma (Houser, 1957). The fact that few young-of-year or yearlings of any of the species of this genus are taken in the lake, even with rotenone, is probably indicative of the lack of knowledge of the habits of the young.
13. *Ictiobus niger*, black buffalo. Very rare in the lake, but the most common of the genus in the tail waters. It is often quite difficult or impossible to distinguish this species from *I. bubalus*.
14. *Ictiobus bubalus*, smallmouth buffalo. Common; taken predominately within five feet of the bottom down to a depth of 40 feet over a silt bottom; occasional in the tail waters.
15. *Carpiodes carpio*, river carpsucker. The most common sucker in Lake Texoma. Very abundant in the lake over sand or silt and

sand bottoms in water as deep as 40 feet, and in the tail waters; usually taken within five feet of the bottom, but also in open water near the surface; young common in tributaries and shallow bays.

16. *Cycleptus elongatus*, blue sucker. Rare in the lake and slightly more common in the tail waters. Usually taken in the lake in the spring at all depths down to 15 feet. No young collected.
17. *Moxostoma erythrurum*, golden redhorse. Very rare in the lake and none known to have been taken in the tail waters; taken regularly in the spring but in small numbers, at the head of Little Mineral Bay.
18. *Minytrema melanops*, spotted sucker. Only five specimens have been taken. Dowell (1956) reported seining two from Buncombe Creek about four miles above the upper limits of inundation at normal level; Bonn has collected one in Buncombe Creek and two in Little Mineral Bay near the Texoma Fisheries Station.

CYPRINIDAE—Minnows

19. *Cyprinus carpio*, carp. Common throughout the lake. Taken at all depths down to 50 feet in the summer, and usually within five feet of the bottom in the winter; fairly common in the tail waters. An important commercial fish in Lake Texoma.
20. *Carassius auratus*, goldfish. Very rare in the lake, only a few large specimens known to have been collected; probably bait-bucket introductions, since it is commonly used as trotline bait.
21. *Hybopsis storeriana*, silver chub. Apparently becoming more abundant in the lake and its tail waters. Commonly seined at night in shallow water over sand bottoms in the Red River arm. The first record of this species from Texas (Bonn and Kemp, 1952) was from Lake Texoma.
22. *Hybopsis aestivalis*, speckled dace. Rare in the lower tail waters and headwaters. None taken in the lake.
23. *Phenacobius mirabilis*, suckermouth minnow. Rare. Taken in the headwaters of Buncombe Creek, and in Kansas Creek, Marshall and Bryan counties, Oklahoma.
24. *Notemigonus crysoleucas*, golden shiner. None known from the main body of the lake; three taken in Buncombe Creek and one in Big Mineral Creek.
25. *Notropis percobromus*, plains shiner. Common in the tail waters, and as late as 1955 it was common in the lake in shallow, sand-bottom areas, particularly wave swept shores. Uncommon since

1955. There is confusion between this species and *N. atherinoides;* many specimens seem to have characteristics of both.

26. *Notropis umbratilis*, redfin shiner. Taken only in Rock Creek, Bryan County, Oklahoma, where it is fairly common.
27. *Notropis brazosensis*, Brazos shiner. Common in the tail waters and occasional in the upstream one-fourth of the lake.
28. *Notropis boops*, bigeye shiner. Taken from Briar and Pennington creeks, Marshall and Johnston counties, Oklahoma.
29. *Notropis lutrensis*, red shiner. The most abundant minnow in Lake Texoma; taken along almost all shorelines. Common in the headwaters and tail waters. Hybrids between this species and *N. venustus* are frequently taken.
30. *Notropis venustus*, blacktail shiner. Common in the sandy or rocky areas of the lake, usually in the clearer water of the downstream two thirds; occasionally abundant in the tail waters and rare in the headwaters. The abundance of this species has apparently declined during the past three years.
31. *Notropis blennius*, river shiner. Rare in the lake; collected over sand bottoms, usually in tributary mouths.
32. *Notropis potteri*, chub shiner. Frequently taken in the tailwaters in the spring; also in many parts of the lake where its numbers are increasing.
33. *Notropis buchanani*, ghost shiner. Common in some parts of the lake, usually the upstream, more turbid regions of the lake and tributaries; occasional in the tail waters.
34. *Notropis bairdi*, Red River shiner. Rare in the lake and headwaters; collected only in Buncombe Creek and at Delaware Bend.
35. *Notropis deliciosus*, sand shiner. Rare in the lake, but fairly common in the more permanent tributaries; occasionally common in the tail waters.
36. *Hybognathus nuchalis*, silvery minnow. Very rare in the lake, its headwaters and tail waters. This species is difficult to distinguish from *H. placita*, and there is some doubt whether they are distinct species.
37. *Hybognathus placita*, plains minnow. Common in the headwaters, silty tributaries, and the silt-bottom shallow areas of the lake; occasional in the tail waters.
38. *Pimephales promelas*, fathead minnow. Rare in the lake, but common in clear tributaries and the tail waters.
39. *Pimephales vigilax*, bullhead minnow. Abundant in most areas of the lake, the tributaries, the headwaters, and the tail waters. The abundance of this species has increased steadily during the

past 10 years until it is now the second most abundant minnow in the lake.

40. *Campostoma anomalum*, stoneroller. Only two specimens known to have been taken in the lake; common in Buncombe and Briar creeks and other rocky, sandy tributaries on the Oklahoma side of the lake.

Ictaluridae—North American Catfishes

41. *Ictalurus punctatus*, channel catfish. Common in most shallow (20 feet deep or less) areas of Texoma, and in the headwaters and tail waters; the most common catfish in the lake. One of the most important game species present.
42. *Ictalurus furcatus*, blue catfish. Fairly common, particularly in the deeper parts (more than 20 feet) of the lake; common in the tail waters.
43. *Ictalurus melas*, black bullhead. Very rare in the lake and the tail waters, but occasionally common in some of the larger tributaries. This species was common in the lake shortly after impoundment, but its numbers steadily declined.
44. *Ictalurus natalis*, yellow bullhead. Known only from Briar and Buncombe creeks where it is taken occasionally.
45. *Pylodictis olivaris*, flathead catfish. Common in most parts of the lake, particularly in the upstream halves of both arms, and in the headwaters and tail waters. An important commercial species on the Oklahoma side of the lake.

Esocidae—Pikes

46. *Esox niger*, chain pickerel. The head of one specimen was collected by Bonn (Sept., 1958). The fish had been caught near the islands on the previous day.

Anguillidae—Eels

47. *Anguilla rostrata*, American eel. Five large specimens are known to have been taken by fishermen through 1950, but none since. Common in the tail waters where we have collected it regularly and where it is frequently caught by fishermen.

Cyprinodontidae—Topminnows or Killifishes

48. *Fundulus notatus*, blackstripe topminnow. Occasional in the quiet areas of the more permanent tributaries.

49. *Fundulus kansae*, plains killifish. Fairly common in the sand-bottom tributaries, particularly Sandy Creek just east of Tishomingo, and in the seepage springs, at the foot of the dam, which are tributary to the tail waters. The very low level of the lake in the winter of 1956–57 apparently greatly reduced the populations of this species.

POECILIIDAE—Livebearers

50. *Gambusia affinis*, gambusia or mosquitofish. Common to abundant in the sluggish areas of tributaries and in many protected bays of the lake. Occasional in backwaters of the tail waters.

MUGILIDAE—Mullets

51. *Mugil cephalus*, striped mullet. At least six specimens are known to have been taken from the tail waters (Riggs, 1957).

ATHERINIDAE—Silversides

52. *Menidia audens*, Mississippi silversides. This species was first reported from the Red River in Oklahoma by Moore and Cross (1950). By 1951 it had become very abundant in the tail waters. Bonn collected the first known specimen from the lake near Delaware Bend in 1953, and no other specimens are known to have been taken in that year. By the summer of 1954 the species was quite common (Riggs and Dowell, 1956), and apparently more abundant than *Labidesthes sicculus*. By 1955 it was obviously the dominant atherinid in the lake (Dowell and Riggs, 1958). At the present time it has apparently completely replaced *Labidesthes*, and only *Dorosoma cepedianum* and perhaps *Dorosoma petenense* appear to be more abundant. It is most frequently taken along sandy shores, particularly near beds of aquatic vegetation.
53. *Labidesthes sicculus*, brook silversides. From 1948 through 1952, this species was one of the most abundant in the lake, probably second only to *Dorosoma cepedianum*. Its numbers declined rapidly during the next three years, although it was still abundant in the tributaries in 1955, and no specimens were taken in the lake or tributaries in 1958 in spite of considerable effort to collect it. The concurrent increase of *Menidia audens* (see above) is possibly responsible for the decrease of *Labidesthes*.

SERRANIDAE—Basses

54. *Roccus chrysops*, white bass. Abundant in most parts of the lake, especially where the bottom is sand or rock. The distribution is

strongly influenced by the distribution of the young-of-year forage speices, particularly *Dorosoma cepedianum*, *Dorosoma petenense*, and *Menidia audens* .Based on direct observations, gill-netting, and intensive angling, the white bass is usually within ten feet of the surface or ten feet of the bottom. The young-of-year frequent sandy and rocky shoals at night, but appear to remain in deeper water during the day. A very important game fish; probably the species most frequently and abundantly taken by anglers.

CENTRARCHIDAE—Sunfishes

55. *Micropterus punctulatus*, spotted bass. Fairly common in many areas of the clearer parts of th lake where the bottom is of sand. gravel, or rock. Although this species has been stocked by Texas hatcheries, it is known to have been in the Red River drainage, above and below the lake, before the lake was impounded. Its abundance has slowly but steadily increased, possibly as the result of wave action creating annually increasing areas of sand, gravel, and rock bottom as the lake matures. Occasional in the tail waters. An important game species.
56. *Micropterus salmoides*, largemouth bass. Common in the tail waters and in most areas of the lake where the depth is less than 20 feet, except the headwaters and turbid tributaries. This species was very abundant shortly after impoundment, but its numbers declined steadily until 1957. The unusually successful reproduction in 1957 increased the abundance of this species. This and *Pomoxis annularis* are the most important game species in the lake.
57. *Chaenobryttus gulosus*, warmouth. Common in quiet, silty bays and coves and in the upper parts of the inundated portions of tributaries. Occasional in the tail waters. Although this species and three of the four species of *Lepomis* present are popular pan fishes elsewhere, they are rarely fished for in Texoma. This is probably because of their small size in this lake.
58. *Lepomis cyanellus*, green sunfish. Uncommon in the lake, but common in many of the clearer tributaries. Occasional in the tail waters.
59. *Lepomis megalotis*, longear sunfish. Common along the shores in all of the clearer parts of the lake, and abundant in the tributaries; occasional in the tail waters. Usually found with *L. macrochirus*.
60. *Lepomis macrochirus*, bluegill. Abundant along the shores in all of the clearer parts of the lake. Common in the tributaries and

tail waters. The bluegill has slowly increased in abundance during the last 10 years with the most marked increase in 1957.

61. *Lepomis humilis*, orangespotted sunfish. Rather common in silty bays, tributaries, and the headwaters.
62. *Lepomis microlophus*, redear sunfish. Very rare in the lake. This species was stocked by Texas hatcheries shortly after the lake was impounded, but the habitat is not suitable. No specimens are known to have been taken since 1953.
63. *Pomoxis annularis*, white crappie. Abundant in nearly all parts of the lake down to a depth of 50 feet; in April and May it is most frequently taken in water less than ten feet deep, and from November through February from 25 to 40 feet deep. Occasional in the tail waters.
64. *Pomoxis nigromaculatus*, black crappie. Very rare. Stocked by Texas hatcheries shortly after impoundment. Only two specimens are known to have been taken during the past five years; these were from the scroll chamber of one of the main generators of the Denison Dam along with several thousand white crappie.

PERCIDAE—Perches

65. *Stizostedion canadense*, sauger. Rare in the tail waters where a few adults are caught each year in April and May by anglers.
66. *Percina caprodes*, logperch. Fairly common in silty areas along the shore and in the tributaries.
67. *Etheostoma radiosum*, orangebelly darter. Four specimens collected from Butcher Pen Creek, Johnston County, Oklahoma.
68. *Etheostoma spectabile*, orangethroat darter. Known from Pennington Creek, Johnston County, Oklahoma; Briar and Buncombe Creeks, Marshall County, Oklahoma; and Rock Creek, Cooke County, Texas. Abundant in Pennington and Buncombe creeks.
69. *Etheostoma gracile*, swamp darter. One specimen taken from the Washita arm near Linn, Marshall County, Oklahoma.
70. *Etheostoma proeliare*, cypress darter. One specimen taken with rotenone from Limestone Creek.

SCIAENIDAE—Drums

71. *Aplodinotus grunniens*, freshwater drum. Fairly common in most of the deeper parts of the lake. In the lake adults weighing more than three pounds are very rare. Abundant in the tail waters where adults up to 30 pounds have been taken.

LITERATURE CITED

BONN, E. W., and ROBERT J. KEMP. 1952. Additional records of freshwater fishes from Texas. Copeia 1952 (3): 204–205.

DOWELL, VIRGIL EUGENE. 1956. Activity patterns and distribution of the fishes in the Buncombe Creek arm of Lake Texoma. Doctor's Dissertation, University of Oklahoma, Norman, Oklahoma.

DOWELL, VIRGIL E., and CARL D. RIGGS. 1958. Further observations on *Astyanax fasciatus* and *Menidia audens* in Lake Texoma. Proc. Oklahoma Acad. Sci. 36 (1955): 52–53.

HOUSER, ALFRED. 1957. A study of the commercial fishery of Lake Texoma. Oklahoma Fish. Res. Lab. Rep't No. 63: 32 pp.

MOORE, GEORGE A., and FRANK BERNARD CROSS. 1950. Additional Oklahoma fishes with validation of *Poecilichthys parvipinnis* (Gilbert and Swain). Copeia 1950 (2): 139–148.

OKLAHOMA PLANNING AND RESOURCES BOARD. 1953. Oklahoma's water resources. Div. of Water Resources: 34 pp.

RIGGS, CARL D. 1954. The occurrence of *Astyanax fasciatus mexicanus* in Lake Texoma, Oklahoma. Proc. Oklahoma Acad. Sci. 33 (1952): 141.

————. 1957. *Mugil cephalus* in Oklahoma and northern Texas. Copeia. 1957 (2): 158–159.

RIGGS, CARL D., and VIRGIL E. DOWELL. 1956. Some recent changes in the fish fauna of Lake Texoma. Proc. Oklahoma Acad. Sci. 35 (1954): 37–39.

RIGGS, CARL D., and GEORGE A. MOORE. 1951. Some new records of paddlefish and sturgeon for Oklahoma. Proc. Oklahoma Acad. Sci. 30 (1949): 16–18.

————. 1958. The occurrence of *Signalosa petenensis* in Lake Texoma. Proc. Oklahoma Acad. Sci. 38 (1957): 64–67.

U. S. ARMY CORPS OF ENGINEERS. 1948. Denison Dam and Lake Texoma information pamphlet Red River, Texas and Oklahoma. Tulsa District, Revision of March 1948 (mimeo.): 22 pp.

UNITED STATES DEPARTMENT OF INTERIOR. 1943. Recreational resources of the Denison Dam and reservoir project Texas and Oklahoma. Nat. Park Serv.: xiv and 98 pp.

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EXPERIMENTAL FEEDING OF WILD QUAIL IN NEW MEXICO

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ABSTRACT. The response of wild populations of scaled and Gambel's quail to artificial feeding of grain was studied, mainly during the three-year period 1954–56. Yearlong feeding was done at water developments in quail habitat of various kinds over a large area. Resultant quail increases, if any, were much too small to justify the high cost of feeding.

INTRODUCTION

One of the game management measures often suggested by sportsmen and others interested in wildlife is artificial feeding, especially of upland game such as quail, pheasants, and turkeys. Superficially, this seems a logical means of bringing about and supporting dense populations of game birds. The present paper describes a field experiment to test the results of distributing grain to populations of wild quail in New Mexico. Dependable information of this sort for all game species is needed for its public relations value if for no other.

Until a few years ago artificial feeding programs were virtually standard game management practice, especially in winter. Public funds in many states have been spent year after year on wildlife feeding considered necessary in routine management. The work of Gerstell (1942) on winter feeding of wildlife in Pennsylvania greatly hastened de-emphasis of artificial feeding as a wildlife management tool in North America. In spite of this and other studies, however, state conservation agencies sometimes find themselves under pressure from sportsmen's groups to carry out wildlife feeding work.

Interest in artificial feeding as a quail management measure has recently revived, partly as a result of work on the bobwhite (*Colinus virginianus*) by Frye (1954), and partly as a result of the advertising efforts of manufacturers of automatic quail feeding devices. Frye, after a competent study covering several years, reported that some local populations of bobwhites in Florida increased substantially through the use of feeders supplying grain. He pointed out, however, that the method was impractical as a public quail management measure because of its high cost. It apparently is useful in quail production on privately managed shooting preserves in parts of the South.

At the Dune Lakes Club, a private shooting preserve in California, a very dense population of California quail (*Lophortyx californica*) was developed by an expensive combination of intensive local predator control and artificial feeding (Glading, Selleck, and Ross, 1945). The procedure apparently was similar to that used in some of the more extreme forms of British game management. The quail population of the area is reported to have reached 4.8 birds per acre in late autumn, and the hunter harvest to have exceeded one quail per habitable acre during the annual hunts of 1939, 1940, and 1941. A fall population of one quail per acre is usually considered high. This heavy Dune Lakes population was maintained by artificial feeding of steel-cut corn, but the investigators concluded that the feeding would not have been effective without intensive predator control. Neither practice in such an extreme form could possibly be justified economically, biologically, or esthetically on a statewide basis in America.

Another California study (Glading, Enderlin, and Hjersman, 1945) showed that artificial feeding alone, without intensive predator control, resulted in small increments to a local population of California quail, but that the method was not economically feasible.

In New Mexico, a large scale experimental feeding program was carried out during the period 1950–56 (mainly from 1954 through 1956) in connection with a water development project for scaled quail (*Callipepla squamata*) and Gambel's quail (*Lophortyx gambelii*). No systematic predator control was involved. Evaluation of quail response to nearly 200 water developments (mostly "gallinaceous guzzlers") was the main objective of the study. These units were widely distributed in quail habitat over the central and southern parts of the state. They were located mostly in desert grassland, but also in mixed grassland and in various shrubby modifications of these two grassland types. Evaluation of the feeding was concurrent with that of the water development.

TECHNIQUES

The typical development consisted of a 700-gallon guzzler, plus a wooden or metal automatic feeder mounted on a rat-resistant platform about 30 inches high. The feeders held from 80 to 100 lbs. of grain. Hegari and other grain sorghums were used in the feeders. A stocktight fence enclosing an acre or two completed the unit. Utilization of water and grain by quail was the major criterion by which the value of units was judged. At each evaluation visit to a unit, quail use was recorded in terms of index numbers. The number system used was as follows: 0 = no utilization; 1 = light use (1–10 birds); 2 = moderate (11–40);

3 = heavy (41–100); 4 = very heavy (101 or more). The terms "light", "moderate", etc., are purely relative and of local application only. This evaluation system worked well for the comparatively low quail utilization which occurred in New Mexico.

Single observations using the index system just outlined were often useful, especially for indicating the greatest bird use ever recorded for a given unit during a given period of time. The main advantage of the use-index numbers, however, was that over-all average utilization, and average highest utilization, of any unit or group of units over any observation period could be approximated by averaging the index numbers recorded at different visits. For this purpose, an extension of the system was devised, thus: 0 = no utilization; 0.1–0.5 = very light use (av. 5 birds); 0.6–1.5 = light (av. 15); 1.6–2.5 = moderate (av. 30); 2.6–3.5 = heavy (av. 60); 3.6–4 = very heavy (av. 120). The last category was seldom needed.

More than 4,000 evaluation visits were made during the three years (1954–56) of most intensive study. These visits, made at all seasons, averaged about seven per unit per year. Bird utilization was determined partly by direct observation and partly by estimates based on sign left by the birds. Sign consisted mainly of tracks, other soil disturbance, droppings, and feathers. After several months of preliminary experience in correlating sign with numbers of birds observed to leave it, reasonably consistent estimates of bird numbers could be made from sign alone. The main possible error, at least in the case of quail, was overestimation of bird usage, not underestimation. Sometimes only two or three quail left a surprising amount of sign, especially tracks. Effective use of the method depended, of course, on the observer's ability to distinguish sign left by quail from that left by mourning doves (*Zenaidura macroura*), roadrunners (*Geococcyx californianus*), and various other birds. This was usually not difficult.

It was not feasible to separate scaled and Gambel's quail in tabulating the results of the study, because a number of units were used by both. Therefore, when quail are mentioned in this paper, both species are meant although actually the study dealt mainly with scaled quail, as these are by far the more numerous and widely distributed in New Mexico. In any case, the reaction of the two species to the guzzlers and feeders did not appear to differ, and therefore lumping them should not affect the validity of the data.

RESULTS AND DISCUSSION

A consistent attempt was made to keep the feeders supplied with grain at all times. This required considerable effort on the part of at

least two men the year around. Heavy feeding by mourning doves and by hordes of small birds, particularly lark buntings (*Calamospiza melanocorys*), often made the task very trying but in spite of this and other difficulties grain was usually available for quail. Scaled and Gambel's quail used the feeders readily, but seldom with the greediness characteristic of doves and smaller birds. Quail usually conducted their business at a feeder with neatness and dispatch, then promptly left in an orderly manner. This behavior was in marked contrast to that of mourning doves and various small birds, certain individuals of which often hung around a feeder for hours. Quail used the feeders mainly between sunrise and noon.

Major results of quail feeding are summarized in Tables 1, 2, and 3. The units were divided into two groups as nearly alike as possible in all respects. Quail use of these groups of units was compared during the period 1954–56. At the units in Group A, grain was supplied during all three years. At the units in Group B it was supplied during the first two years, but during the third year water only was available.

Table 1 shows the over-all results for quail, averaging all observa-

TABLE 1

Estimated Over-all Average Quail Use of Two Groups of Units During Three Years

	Group A (Water and grain)		Group B (Water only after 1–1–56)		Differences	
Years	No. of Units	Average over-all use-index	No. of Units	Average over-all use-index	Amount	In favor of group
1954	83	0.9	63	0.9	0	...
1955	103	1.0	79	1.0	0	...
1956	103	1.4	79	1.1	0.3	A

TABLE 2

Estimated Highest Average Quail Use of Two Groups of Units During Three Years

	Group A (Water and grain)		Group B (Water only after 1–1–56)		Differences	
Years (last six months only)	No. of Units	Average highest use-index	No. of Units	Average highest use-index	Amount	In favor of group
1954	83	1.2	63	1.4	0.2	B
1955	103	1.7	79	1.6	0.1	A
1956	103	2.1	79	1.6	0.5	A

TABLE 3

Estimated Quail Use of Seven Pairs of Matched Units During Three Years

Pair No.	Group A (water and grain) Unit No.	Average over-all use-index	Highest recorded use-index	Group B (water only) Unit No.	Average over-all use-index	Highest recorded use-index
1	B-2(A)	1.3	3	B-1(GPA)	1.2	3
2	DA-8	1.1	2	DA-3	0.2	1
3	DA-14	0.5	2	DA-15	0.7	2
4	Hid-15	2.3	4	Gr-5	1.6	3
5	Hid-7	1.7	3	Hid-6	1.0	2
6	Lun-6	1.7	3	Lun-7	1.8	3
7	Soc-24	0.5	2	Soc-23	0.4	2
Averages		1.3	2.7		1.0	2.3

tions made during each year. Apparently the feeding did result in slightly higher average quail utilization of the units. The identical averages at the two groups of units in 1954 and 1955 imply that these unit groups were very similar and hence were legitimately comparable.

Table 2 summarizes the average highest recorded quail use of the same two groups of units for the last six months of each year. By including only the highest recorded use-index for each unit during that period each year the table reflects average maximum observed utilization of the units. In New Mexico, more quail ordinarily used the units in the fall than at any other time. Only the last six months were considered in order to eliminate the possibility that in Group B (no grain in 1956) some high use indexes would be recorded early in 1956 which were really due to holdovers from feeding just terminated. Leaving out the first six months of each of the other two years makes the table strictly comparable throughout. This table supports Table 1 in its indication that the two groups of units were really comparable, and that the feeding probably did lead a few more quail, on the average, to use the units. Possibly the feeding also resulted in the production and/or survival of a few additional quail, but this is unproved.

During the entire three-year period of intensive investigation 14 units in seven matched pairs were subjected to special study. One unit of each pair had both water and grain at all times, while the other had water only. The results are shown in Table 3. The figures again indicate that consistent feeding resulted in greater quail use, and may have made possible the existence of a few more quail. An attempt was made to match the units accurately, but mismatching of one or more

pairs of similar-appearing units may have exaggerated the average differences between the two sets.

Assuming that the differences shown in the three tables mean that feeding actually made possible the existence of some additional quail, observed and calculated differences convincingly demonstrate the practical futility of artificial feeding. In terms of actual bird numbers it appears certain that an average of not more than 10 or 15 additional quail per unit were produced annually by the feeding. Indeed, it is possible that the difference in quail use between feeder and non-feeder units was due to influx rather than to increase. But even if as many as 15 additional quail per unit were produced, the result must be considered negligible from the game management standpoint. Not more than five or six of these extra 15 birds would, on the average, be taken by hunters under usual conditions.

ECONOMIC CONSIDERATIONS

A large-scale wildlife feeding program like that described in this paper is an expensive undertaking. During the three and one-half year period between July 1, 1953 and December 31, 1956, about 98,000 lbs. (44.2 tons) of grain were fed. Quail probably consumed not over 25% of the total, most of the remainder going to mourning doves and to many smaller birds, plus a minor share to rodents. This grain was produced on state-owned farms at the very moderate cost of about $2,500. Most of the expenses in a wildlife feeding project of this kind are incurred in distributing the grain, once the feeders have been built and installed. This distribution cost is excessive where long distances must be traveled. In this study it was impossible to determine distribution costs because the feeders were supplied as part of the larger maintenance project on the water units. However, distribution costs could hardly have been less than $8,000 per year and they may have been more. For example, during the fiscal year 1955–56 the total cost of maintaining the quail units was $15,300. Nearly $4,000 of this went for truck operation alone. Since guzzlers require little maintenance, most visits were necessary only for servicing the feeders. Therefore, half or more of the total maintenance expenditure seems properly chargeable to feeding.

Even though some positive results seem to have been attained, these were too small to justify such expenditures. Even if the results had been much greater, large-scale feeding could hardly be justified economically when we consider that only a minute fraction of the total quail population of New Mexico was affected even by our extensive project.

CONCLUSIONS

The main conclusions of this study are that supplemental grain feeding did not produce important increases in populations of scaled and Gambel's quail living under natural conditions in New Mexico even when water also was provided; that small local increases which probably resulted from the feeding were economically unjustifiable on a publicly financed basis because of the high costs involved; and that these results suggest that the expenditure of public funds on artificial feeding programs for the supposed benefit of Southwestern quail should be discouraged. Thus the study tends to confirm the results of several previous studies in other states, as well as the considered opinions of many students of game who have critically examined the problem of artificial feeding as a tool of wildlife management.

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LITERATURE CITED

FRYE, O. E., JR. 1954. Studies of automatic quail feeders in Florida. Trans. N. Amer. Wildl. Conf., 19: 298–316.

GERSTELL, R. 1942. The place of winter feeding in practical wildlife management. Penn. Game Comm., Research Bul. 3.

GLADING, B., ENDERLIN, R. W., and HJERSMAN, H. A. 1945. The Kettleman Hills quail project. Calif. Fish and Game, 31 (3): 139–156.

GLADING, B., SELLECK, D. M., and ROSS, F. T. 1945. Valley quail under private management at the Dune Lakes Club. Calif. Fish and Game, 31 (4): 167–183.

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THE AMERICAN PERCID FISHES *AMMOCRYPTA CLARA* JORDAN AND MEEK AND *AMMOCRYPTA PELLUCIDA* (BAIRD)[1]

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ABSTRACT. The two species, *Ammocrypta clara* Jordan and Meek and *Ammocrypta pellucida* (Baird), are shown to be distinct on the basis of scale counts, opercle structure and pigmentation. The original descriptions of these two species were based on syntypes. Lectotypes are designated and described.

Specimens of *Ammocryta clara* Jordan and Meek were collected in Oklahoma for the first time from the Red River south of Bennington, Bryan County, Oklahoma on October 28, 1953. Considerable confusion has existed as to the taxonomic status of this form and the closely related species, *Ammocrypta pellucida* (Baird). It seemed advisable to examine representatives of these species from various parts of their range to determine their relationship.

The original descriptions of these two species are based on syntypes. Dr. E. A. Lachner of the United States National Museum suggested that a lectotype be selected for each species and descriptions published.

MATERIALS EXAMINED

The following abbreviations are used in this paper: ISC-Iowa State College; OSU-Ohio State University, Stone Institute of Hydrobiology; OAM-Oklahoma State University; USNM-United States National Museum; UMMZ-University of Michigan Museum of Zoology; U. Minn.-University of Minnesota; UMoMZ-University of Missouri Museum of Zoology. State, institutional designation, museum number (when available), the number of specimens studied (in parentheses) and locality are given in that order.

Ammocrypta clara—Iowa: ISC 184 (18), Des Moines River at U. S. Highway 30, 3.5 miles SW of Boone, Boone Co.; USNM 35828 (four syntypes of *Ammocrypta clara*), Des Moines River at Ottumwa. Minnesota: U. Minn. 9048 (10), slough on Mississippi River above Wi-

[1] Contribution (No. 247) from the Zoology Department, Oklahoma State University, Stillwater and from the Zoology Department, Wichita University, Wichita, Kansas.

nona; U. Minn. 16828 (6), Mississippi River at Dakota, Winona Co. Missouri: UMoMZ (2), Meramac River, 1 mile south of Pacific, Jefferson Co.; UMoMZ B58 (1), St. Francis River, 4 miles south of Senath, Dunklin Co.; UMoMZ (collecting station M41–347) (3), Salt River (lower CFC Station); Missouri Conservation Commission (1), Lower Salt River, six miles north of Center. Oklahoma: OAM 5000 (6), Red River near mouth of Blue River, south of Bennington, Bryan Co. Wisconsin: UMMZ 76089 (10), Black River, south of Black River Falls, Jackson Co.

Ammocrypta pellucida—Indiana: UMMZ 99920 (6), Eel River near Hoovers, Cass Co. Ohio: OAM 4899 (3), Big Darby Creek at Fox, Pickaway Co.; OSU 9–290 (28), Hocking River, Troy Twp., Athens Co.; OSU 599 (37), Ohio River at Dam 29, Perry Twp., Lawrence Co.; OSU 908 (9), Muskingum River, .5 miles south of Harrison, Hamilton Co.; OSU 5056 (27), Big Darby Creek, Darby-Scioto Twp., Pickaway Co.; USNM 1311 (21 syntypes of *Pleurolepis pellucidus* Baird), Black River at Elyria.

Counts and measurements were taken from specimens included in the above collections (76 of *pellucida* and 52 of *clara*, including the 21 types of *Pleurolepis pellucida* and four types of *Ammocrypta clara*). Numerous other specimens of these species were examined and verified (Fig 1).

METHODS

Scale rows above the lateral line were counted from the origin of the dorsal fin on a diagonal downward and posteriorly to the lateral-line scale row. Scale rows below the lateral line were counted from the origin of the anal fin on a diagonal upward and anteriorly to the lateral-line scale row. The total number of scale rows on the side of the body was obtained by adding one (the lateral-line scale row) to the sum of the two above counts. Other data were taken according to the methods of Hubbs and Lagler (1949). Proportional measurements show no distinct differences between these two species of *Ammocrypta*. Since the type material is old and poorly preserved, it did not seem necessary or advisable to take proportional measurements from it.

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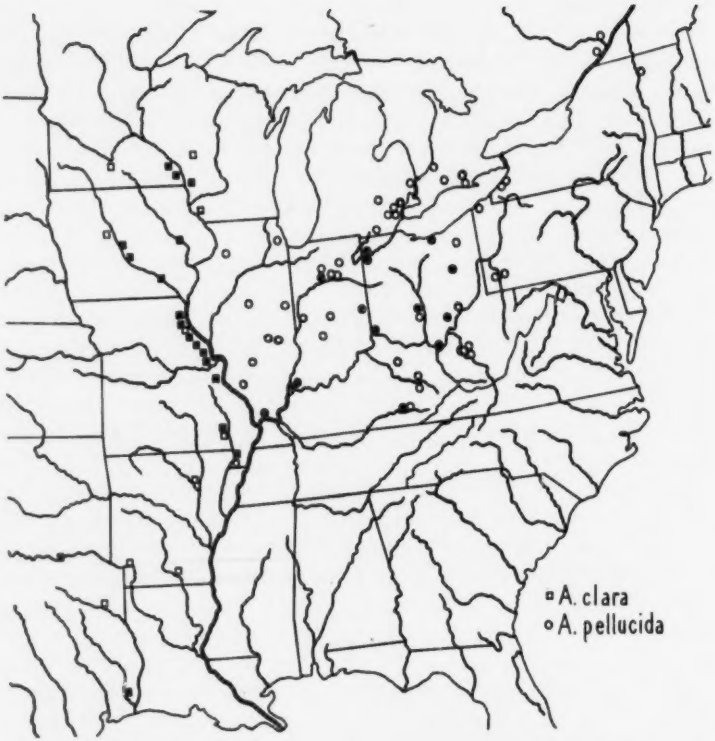

Fig. 1. Distribution of *Ammocrypta clara* and *Ammocrypta pellucida*. Solid figures refer to specimens examined, open figures represent literature references and museum specimens not examined.

Museum, University of Michigan Museum of Zoology, University of Minnesota, and University of Missouri. I am indebted to George A. Moore of Oklahoma State University for suggestions and criticisms; to D. L. Miller of Carlsbad, New Mexico for field assistance; and to E. A. Lachner of the United States National Museum for use of type specimens and supplying museum numbers.

Ammocrypta clara Jordan and Meek

The original description of this species was based on three different collections (USNM 36488, 1 specimen from Texas, Sabine River at Longview; USNM 36337, 2 specimens from Arkansas, Red River at Fulton; USNM 35828, 4 specimens from Iowa, Des Moines River at

Ottumwa). Jordan and Evermann (1896) designated the four Iowa specimens as the types of *A. clara*. In the original description Jordan and Meek (1885) stated that *clara* was very closely related to *A. pellucida*, but that it had less perfect squamation. Evermann and Jenkins (1888) compared *pellucida* and *clara* (listed in the genus *Etheostoma* by these authors) and reported high variability in lateral scale rows of *pellucida* with considerable overlapping with *clara*. They concluded that *clara* should be considered a subspecies of *pellucida*. Since that time some authors have adhered to the original description and have given *clara* specific status (Jordan, 1905; Gerking, 1945; Eddy and Surber, 1947; Starret, 1950; Jurgens and Hubbs, 1953; Knapp, 1953; and Moore, 1957, *fide* the present study). Other authors have followed the example set by Evermann and Jenkins (1888) and have listed *clara* as a subspecies of *pellucida* (Jordan and Evermann, 1896; Cox, 1896; Jordan, 1904). Hubbs and Green (1927) reached the conclusion that no subspecies of *pellucida* should be recognized and implied that the name *clara* should be relegated to synonymy. Pratt (1935) included only three species of *Ammocrypta* in his manual, apparently not recognizing *clara* as a valid species. Wickliff and Trautman (1937), Welter (1938), Raney (1939) and Fowler (1948) listed *pellucida* in the trinomial, indicating that other subspecies were recognized. Carlander (1941) referred to *pellucida* in the binomial and listed *A. p. clara* as a synonym.

I have found, as did Evermann and Jenkins (1888), that the total number of lateral scale rows overlap in *A. clara* and *A. pellucida*. However, the average number of scale rows on the sides and opercular structure together indicate a difference between the two forms. In *clara* the opercle is prolonged into a thin needle-like spine, whereas in *pellucida* it is merely a triangulate bone with a small, pointed corner.

Distribution. Ammocrypta clara is known to occur from Minnesota and Wisconsin southward to Texas and Arkansas and southwestward from Indiana to Oklahoma (Fig. 1).

Diagnosis. Ammocrypta clara has the cheeks and opercles scaled, the nape naked or with scattered, embedded scales; and belly naked. There are 0–2 (av. 1.0) scale rows above the lateral line, 2–3 (av. 2.2) below and a total of 3–5 (av. 4.2) rows on the sides (Table 1). The opercle is projected into a needle-like spine as shown in Jordan and Evermann (1900, Plate 172, Figure 454).

Pigmentation is less prominent than in *A. pellucida*. Small blotches, in one median dorsal and two midlateral series and usually covering 2 to 3 scale rows, are observable; the lateral ones are elongated longitudinally. A lateral row of melanophores, directly below the lateral-

TABLE 1

Frequency distribution of body scale rows of Ammocrypta clara and Ammocrypta pellucida.

	Scale rows above the lateral line									Number of	
	0	1	2	3	4	5	6	7	8	specimens	Ave.
clara	3	46	3							52	1.0
pellucida	1	7	4	16	20	18	7	3		76	3.8

	Scale rows below the lateral line									Number of	
	2	3	4	5	6	7	8	9	10	specimens	Ave.
clara	41	11								52	2.2
pellucida		1	10	21	17	16	10	1		76	5.9

	Total scale rows on the side of body															Number of	
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	specimens	Ave.
clara	2	37	13												52	4.2
pellucida				3	6	6	7	13	10	12	5	9	5		76	10.8

line scale row, extends the full length of the body and merges with the lateral blotches to form an irregular band.

Description of Lectotype. I designate a specimen (sex undetermined) 42.5 mm. in standard length as the lectotype of *Ammocrypta clara* Jordan and Meek and retain the original number (USNM 35828). The remaining three specimens (USNM 164166), included in the syntype series of *A. clara* by Jordan and Evermann (1896), are designated as paratypes.

The meristic data of the lectotype, with the ranges of variation of the paratypes in parentheses, are as follows. Scales: in lateral line 72 (66–75); above lateral line 1 (1, in all); below lateral line 2 (2, in all); total rows on side 4 (4, in all). Fin rays: D XI (XI, in all)-10 (10–11); A I, 9 (I, 8–9); P_1 14–14 (12 to 14, both sides); P_2 always I, 5; C 17 (16–18).

Cheeks and opercles scaled, nape naked (scattered, embedded scales in two paratypes); belly naked.

No variation in the lateral-line system of the head was observed. Supraorbital canals complete with 4 pores each and a coronal pore present; infraorbital canals, complete with 8 pores; preoperculomandibular and supratemporal canals complete.

The lectotype is faded, but the following pigmentation can be observed. The dorsal fins are devoid of pigment, except for small puntulations in the membranes along the spines and soft rays; other fins devoid of pigment, except for small melanophores at their base. Head, anterior to the eyes, with small dorso-lateral punctulations extending

from one premaxilla to the other; cheeks and opercles with small pigment cells. Occipital region with clusters of small melanophores. Dorsum well covered with small melanophores which tend to form blotches (easily observed in freshly-fixed specimens). Venter almost devoid of pigment, some melanophores on rami of caudal and anal fin rays and a row of pigment cells from caudal to anal fin. Sides of body with a well-defined row of melanophores which begins anteriorly on the scale row below the lateral line and extends the full length of the body to end on the lateral-line scale row at caudal base. The melanophores in this row tend to be concentrated in several places, forming well-defined blotches, more easily observed in freshly-fixed specimens.

Ammocrypta pellucida (Baird)

Jordan and Gilbert (1883) first placed this species in the genus *Ammocrypta* (originally described in *Etheostoma* by Baird in Putnam, 1863:5, but assigned to *Pleurolepis* by Agassiz, in Putnam, 1863:5; the latter name was preoccupied by a genus of fossil ganoid fish) (Neave, 1939). The incomplete, original description was based on three different collections (USNM 1311, 21 specimens from Ohio, Black River at Elyria; USNM 1289, 1 specimen from Michigan at Port Huron; and USNM 1295, 1 specimen from Michigan, Detroit River). Jordan and Everman (1896) designated the collection from Ohio (USNM 1311) as the types of this species.

Ammocrypta pellucida, in the past confused with *A. clara*, is distinguished from *clara* by the absence of the needle-like opercular spine, the higher average number of scale rows on the sides and by the greater amount of pigment on the body. *Distribution. Ammocrypta pellucida* is known to occur from southern Quebec and Ontario southward to West Virginia and from Vermont westward to Illinois (Fig. 1). *Diagnosis.* The cheeks and opercles of *pellucida* are usually scaled, but are naked in some specimens. Although the nape is most often naked, some specimens have scattered, embedded scales. This species has 0–7 (ave. 3.8) scale rows above and 3–9 (ave. 5.9) rows below the lateral line, with a total of 6–15 (ave. 10.8) rows on the sides (Table 1). The opercle is triangular in shape but lacks the well-defined spine found in *clara*.

Pigmentation is generally more prominent than in *clara*. The lateral and dorsal blotches are longer, covering from 2 to 4 scale rows, and longitudinally elongated as in *clara*. The lateral row of melanophores, present in *clara*, is generally absent, but when present it is incomplete and observable from the second scale row below the lateral line to the lateral-line scale row at the caudal base. *Description of*

Lectotype. I designate a specimen (sex undetermined) 49.9 mm. in standard length as the lectotype of *Ammocrypta pellucida* (Baird) and retain the original number (USNM 1311). The remaining 20 specimens (USNM 164165), included in the type series of *A. pellucida* by Jordan and Evermann (1896), are designated as paratypes.

The meristic data for the lectotype, with range of paratypes in parentheses, are as follows. Scales: in lateral line 74 (68–79); rows above lateral line 5 (2–7); rows below lateral line 6 (3–8); total rows on sides of body 12 (7–15). Fins: D X (IX–X)–11 (9–11); A I, 9 (I,8–10); P_1 16–15 (14 to 16–14 to 16); P_2 I,5 in all; C 15 (15–18).

Cheeks, opercles and nape are scaled in lectotype, naked in many of the paratypes.

Lateral line system of head: supraorbital canals complete with 4 pores each, a coronal pore is present; infraorbital canals complete with 8 pores; preoperculomandibular and supratemporal canals complete

Although the type specimens are poorly preserved and faded, the following pigmentation was observed on the lectotype. The dorsal fins have pigment cells only in the membranes along the rays and spines; caudal, anal and pectorals have melanophores basally scattered in the membranes along the rays; pelvics devoid of pigment. The head pigmentation is essentially as in *A. clara.* Dorsum with 13 prominent blotches in between which are scattered melanophores that tend to follow the posterior edges of the scales. Venter with a row of melanophores from caudal to anal fin and scattered melanophores on lower jaw. Sides of body with 12 (13 in some paratypes) prominent blotches; scales outlined on posterior edges by small melanophores.

DISCUSSION

The two forms of *Ammocrypta*, discussed in this paper, should be considered distinct species. It is believed that there are sufficient differences in opercular structure, scale counts, and pigmentation to justify maintaining them as distinct species.

The distribution of the two species presents an interesting pattern. On the basis of specimens examined and museum records, *Ammocrypta pellucida* is found east of the Mississippi River in the tributaries of this river in Illinois, in the Ohio River and its tributaries, and in some of the tributaries of the Saint Lawrence River, Lake Huron, Lake St. Claire and Lake Erie. *Ammocrypta clara* is found primarily west of the Mississippi River. The latter species is found on both sides of this river in the upper regions (i.e. Minnesota and Wisconsin) but from northern Illinois southward it has been collected east of the

Mississippi River only from southern Indiana and it is represented here by a single specimen taken from the Wabash River at Mackey Ferry, 7 miles west of Mt. Vernon (Gerking, 1945) (Fig. 1).

LITERATURE CITED

CARLANDER, K. D. 1941. The darters (Etheostominatinae) of Minnesota. Proc. Minn. Acad. Sci., 9: 41–8.

COX, U. O. 1896. A report of fishes of southwestern Minnesota. Rept. U. S. Fish. Comm., 20 (1894: 605–16.

EDDY, SAMUEL, and THADDEUS SURBER. 1947. *Northern Fishes.* Univ. Minn. Press, 276 pp.

EVERMANN, B. W., and O. P. JENKINS. 1888. Notes on Indiana Fishes. Proc. U. S. Nat. Mus., 11: 43–51.

FOWLER, H. W. 1948. A list of the fishes recorded from Pennsylvania. Board of Fish Comm., Penn., Bull. 7: 1–26.

GERKING, S. D. 1945. The distribution of fishes in Indiana. Invest. Ind. Lakes and Streams, 3 (1): 1–137.

HUBBS, CARL L., and C. W. GREENE. 1927. Further notes on the fishes of the Great Lakes and tributary waters. Papers Mich. Acad. Sci., Arts and Letters, 8: 371–92.

————, and K. F. LAGLER. 1949. Fishes of the Great Lakes Region. Cranbrook Inst. Sci., Bull. 26: 1–186.

JORDAN, D. S. 1904. *A Manual of Vertebrate Animals of the Northern United States.* A. C. McClung and Co., 393 pp.

————. 1905. *A Guide to the Study of Fishes.* H. Holt and Co., Vol. I, 624 pp; Vol. II, 599 pp.

JORDAN, O. S., and B. W. EVERMANN. 1896. The Fishes of North and Middle America. U. S. Nat. Mus., Bull. 47, Vol. I, 1240 pp.

————, and ————. 1900. The Fishes of North and Middle America. U. S. Nat. Mus., Bull. 47, Vol. 4: pl. 172, fig. 454.

JORDAN, O. S., and C. H. GILBERT. 1883. Synopsis of the Fishes of North America. U. S. Nat. Mus., Bull. 16, 1018 pp.

JORDAN, O. S., and S. E. MEEK. 1885. List of fishes collected in Iowa and Missouri in August, 1884, with descriptions of three new species. Proc. U. S. Nat. Mus., 8 (1): 1–17.

JURGENS, K. D., and CLARK HUBBS. 1953. A checklist of Texas freshwater fishes. Texas Game and Fish Mag., 11 (4): 12–15.

KNAPP, F. T. 1953. *Fishes Found in Freshwaters of Texas.* Ragland Studio and Litho. Print. Co., 166 pp.

MOORE, G. A. (in Blair, W. F., A. P. Blair, P. Brodkorb, F. R. Cagle and G. A. Moore). 1957. *Vertebrates of the United States.* McGraw-Hill Book Co., Inc., 210 pp.

NEAVE, S. A. 1939. Nomenclator Zoologicus. Zool. Soc. of London, Vol. 3, 1065 pp.

PRATT, F. W. 1863. *A Manual of Land and Freshwater Vertebrate Animals of the United States (Exclusive of Birds)*. P. Blakiston's Son and Co., 2nd Ed., 416 pp.

PUTNAM, F. W. 1863. List of the fishes sent by the museum to different institutions, in exchange for other specimens, with annotations. Mus. Comp. Zool., Bull. 1 (1): 1–16.

RANEY, E. C. 1939. The distribution of fishes of the Ohio Drainage Basin of western Pennsylvania. Thesis Abstract, Cornell Univ., 273–7.

STARRETT, W. C. 1950. Distribution of the fishes of Boone County, Iowa, with special reference to minnows and darters. Amer. Midl. Nat., 43 (1): 112–27.

WELTER, W. A. 1938. A list of fishes of the Licking River Drainage in eastern Kentucky. Copeia, (2): 64–8.

WICKLIFF, E. L., and M. B. TRAUTMAN. 1937. List of the fishes of Ohio. Ohio Dept. of Agri., Div. Conserv., Bull., 1: 1–4.

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ANNOTATED CHECK LIST OF THE CLADOCERA AND COPEPODA OF LYON COUNTY, KANSAS

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ABSTRACT. Thirty-four species of Cladocera and 18 species of Copepoda were identified in samples taken from 33 cattle ponds, 21 streams, 9 roadside ditches, and 6 sloughs in Lyon County, Kansas, during the period September, 1958, to April, 1959. These species are listed in a check list with annotations of their relative abundance and seasonal occurrence as well as the water temperature and pH ranges of their habitats. *Chydorus sphaericus* (O.F.M.) was the most frequently collected copepod. Locality data for 4 species of Cladocera and Copepoda not reported previously in Kansas are included.

Although a few publications list the Cladocera and Copepoda which are known to occur in certain limited regions or selected habitats of Kansas (Leonard and Ponder 1949, Ratzlaff 1951, and Prophet 1957, 1959), a complete check list of the Cladocera and Copepoda of Kansas has not been published. To one interested in the ecology and distribution of these crustaceans, a check list covering various geographical regions or states is invaluable. However, a check list that would include the Cladocera and Copepoda of an entire state would take many years to prepare. A complete check list of the Kansas species would require many field samples, since there are few recently published records that could serve as a foundation upon which an extensive check list could be built.

The present list includes only those species which have been collected in Lyon County, which is a part of the Arkansas River system draining the southern half of Kansas. It is based on 69 separate field collections taken throughout Lyon County by the authors during the period September, 1958, to April, 1959, and upon published and unpublished records of other investigators who have collected and studied the Cladocera and Copepoda of Lyon County during the past ten years (Ratzlaff 1951, Wilhm 1955, and Davies 1958).

This list is obviously not complete but rather it is a basis for future studies in Lyon County and for a comprehensive check list of the entire state. It is hoped that the present list will be of value by showing which species are most likely to appear in samples taken from Lyon County and possible patterns of seasonal and habitat occur-

rence. Water temperature and pH ranges of the habitats for each species are included in the annotated list of species.

Identifications were based on keys in *Fresh-water Invertebrates of the United States* (Pennak 1953). The authors are grateful to Mildred S. Wilson of the Arctic Health Center, Anchorage, Alaska, for aid in the identification of Copepoda, and to Dr. David G. Frey, Indiana University, for aid in identifying certain cladocerans.

The following check list is based on 69 samples taken from 33 ponds, 21 streams, 9 roadside ditches, and 6 sloughs. The ponds ranged in size from about one to 20 surface acres and from very turbid, unfenced cattle ponds to densely vegetated fenced impoundments. Vegetation common to fenced impoundments included *Typha*, *Carex*, *Cephalanthus*, *Andropogon*, *Sagittaria*, and *Potamogeton*. Vegetation most commonly associated with ditch habitats consisted primarily of *Typha*, *Carex*, *Eleocharis*, *Polygonum*, and *Andropogon*. Small, temporary shallow bodies of water were classed as sloughs with *Andropogon* representing the dominant form of vegetation. It is difficult to group cladocerans or copepods into categories which would reveal their true relative abundance and frequency of occurrence in any given habitat, for many of these crustaceans exhibit seasonal pulses. They may be abundant one month but absent or relatively scarce the next. Samples at different times of the year might reveal results different from those presented in this check list. However, the following terms and definitions were used by the authors to indicate the relative abundance of species and the frequency with which they occurred in samples during the present study.

Common; individuals found regularly in most habitats, usually in relatively large numbers. *occasional;* individuals occurring irregularly, mostly present in relatively small numbers, at times numerous. *scarce;* specimens rarely found; usually occurring in small numbers.

ORDER CLADOCERA

Sididae

Diaphanosoma brachyurum (Liévin). Common. Found in all habitats during the fall. Water temperature 5° to 30° C.; pH 7.2 to 9.4. It is doubtful that this species occurs regularly during other seasons.

Daphnidae

Daphnia pulex (de Geer). Common. Found primarily in ponds throughout the year. Water temperature 1° to 30° C; pH 7.2 to 9.4.

Daphnia longispina (O.F.M.). Occasional. In ponds, streams, and

roadside ditches. Water temperature 1° to 30° C; pH 7.2 to 8.2. [According to Brooks (1957), *D. longispina* does not occur in North America. He suggests that species from Kansas previously keyed to *D. longispina* were probably *D. ambigua* Scourfield, 1947.]

Simocephalus exspinosus (Koch). Scarce. Collected during September in a heavily vegetated pond; water temperature 22.8° C. and pH 8.2. Also in a prairie slough; water temperature 21.7° C and pH 7.6.

Simocephalus vetulus (O.F.M.). Occasional. Inhabits ponds, ditches, and sloughs during fall and winter. Water temperature 2° to 15.9° C., pH 7.4 to 8.8.

Simocephalus serrulatus (Koch). Scarce. Fall and winter inhabitant of ponds. Water temperature 4.3 to 20.2° C., pH 7.9 to 8.2.

Scapholeberis mucronata (O.F.M.). Occasional. Fall and winter inhabitant of ponds, roadside ditches, and sloughs. Water temperature 15° to 27° C.; pH 7.4 to 8.2.

Ceriodaphnia rigaudi Richard. Occasional. In ponds and streams during fall and winter. Water temperature 15.2° to 21.4° C.; pH 7.4.

Ceriodaphnia reticulata (Jurine). Occasional. Year-round inhabitant of ponds and roadside ditches. Water temperature 2° to 30° C.; pH 7.4 to 8.3. Reported in Lyon County by Davies (1958), Ratzlaff (1951), and Wilhm (1955); not encountered by authors.

Ceriodaphnia lacustris Birge. Occasional. In ponds, roadside ditches, and sloughs. Water temperature 11° to 21.7° C.; pH 7.6 to 8.8.

Ceriodaphnia laticaudata P. E. Muller. Scarce. Collected from a small pond during September. Water temperature 20.2° C.; pH 8.2.

Ceriodaphnia quadrangula (O.F.M.). Scarce. Ponds and roadside ditches during late fall. Water temperature 9.1° to 13.5° C.; pH 7.4 to 8.1.

Moina macrocopa Straus. Scarce. Collected from a small stream during September. Water temperature 20.2° C.; pH 7.4.

Moina brachiata (Jurine). Occasional. Mainly in ponds during fall. Water temperature 3° to 21.9° C.; pH 7.2 to 8.2.

Moina rectirostris (Leydig). Scarce. Reported by Ratzlaff (1951) from a roadside ditch during summer and fall. Water temperature 5° to 25° C.; pH 7.3 to 7.9.

Bosminidae

Bosmina longirostris (O.F.M.). Common. Occurring in all types of habitats during fall and winter. Water temperature 3° to 30° C.; pH 7.1 to 8.1. This species probably occurs in most habitats throughout the year.

Bosmina coregoni Baird. Occasional. Ponds, roadside ditches, and

sloughs during the fall. Water temperature 5.8° to 18.8° C.; pH 7.6 to 9.4.

Macrothricidae

Ilyocryptus spinifer Herrick. Scarce. Collected from ponds during February and April. Water temperature 6.5° to 13.2° C.; pH 7.6 to 8.2.

Macrothrix laticornis (Jurine). Common. Ponds, roadside ditches, and sloughs during the fall. Water temperature 6.5° to 22° C.; pH 7.6 to 9.4.

Chydoridae

Kurzia latissima (Kurz). Occasional. Ponds and streams during the fall. Water temperature 7.2° to 11° C.; pH 8.4 to 9.3.

Camptocercus rectirostris Schödler. Scarce. Reported by Davies (1958) from a small lake during the winter and spring. Water temperature 1° to 12° C.; pH 7.4 to 8.0.

Camptocercus oklahomensis Mackin. Scarce. Collected from a vegetated prairie roadside ditch during April. Water temperature 18.4° C.; pH 8.0.

Leydigia quadrangularis (Leydig). Occasional. Ponds, roadside ditches, and sloughs during fall, winter, and spring. Water temperature 6.3° to 19° C.; pH 7.6 to 8.4. It is probable that this species occurs the year-round in many habitats.

Leydigia acanthocercoides (Fischer). Scarce. Collected from a roadside ditch during November. Water temperature 12.5° C.; pH 7.4.

Alona guttata Sars. Occasional. Mainly in streams and roadside ditches during the fall. Water temperature 6.0° to 19.2° C.; pH 7.9 to 8.4.

Alona quadrangularis (O.F.M.). Scarce. Reported by Ratzlaff (1951) in a roadside ditch during spring and fall. Water temperature 5° to 27° C.; pH 7.3 to 7.9.

Alona costata Sars. Occasional. Mainly in ponds during fall and winter. Water temperature 1° to 30° C.; pH 7.2 to 8.2.

Alona rectangula Sars. Common. Ponds, streams, and roadside ditches during fall and winter. Water temperature 5.8° to 22.8° C.; pH 7.3 to 9.3. This species probably occurs the year-round.

Pleuroxus striatus Schödler. Scarce. Reported by Davies (1958) from a small lake during fall and winter. Water temperature 4° to 20° C.; pH 7.2 to 7.8.

Pleuroxus hamulatus Birge. Occasional. In all types of habitats during fall and winter. Water temperature 5.8° to 20.2° C.; pH 7.4 to 9.4.

Pleuroxus denticulatus Birge. Common. Occurred in all habitats, but

found mainly in ponds during fall and spring. Water temperature 7.2° to 22.8° C.; pH 7.4 to 9.3.

Chydorus globosus Baird. Scarce. Collected from a turbid pond during February. Water temperature 6.9° C.; pH 7.3.

Chydorus gibbus Lillj. Scarce. Collected from a roadside ditch during November. Water temperature 11.3° C.; pH 8.4.

Chydorus sphaericus (O.F.M.). Common. Most frequently collected cladoceran. Occurring in all types of habitats during spring and fall. Water temperature 5° to 30° C.; pH 7.3 to 9.4. It is probable that this species occurs in most habitats the year-round.

Alonella rostrata (Koch). Scarce. Collected from a clear pond during February. Water temperature 6.8° C.; pH 7.8.

SUBCLASS COPEPODA

ORDER EUCOPEPODA

Cyclopidae

Paracyclops fimbriatus (Fischer). Common. Ponds, streams, and roadside ditches the year-round. Water temperature 1° to 30° C.; pH 7.1 to 9.2.

Eucyclops agilis (Koch). Common. All types of habitats during fall and winter. Water temperature 1° to 30° C.; pH 7.2 to 9.3.

Eucyclops prasinus (Fischer). Common. In all types of habitats early spring through fall. Water temperature 5° to 27° C.; pH 7.4 to 9.4. This species has been redescribed as *Tropocyclops prasinus* (Fischer) (Kiefer 1931).

Macrocyclops ater (Herrick). Occasional. Streams and roadside ditches, spring, summer, and fall. Water temperature 10° to 27° C.; pH 7.3 to 8.0.

Macrocyclops albidus (Jurine). Occasional. Fall inhabitants of all habitats. Water temperature 7.6° to 20.2° C.; pH 7.4 to 8.2.

Mesocyclops leuckarti (Claus). Occasional. In ponds, roadside ditches, and sloughs during fall and winter. Water temperature 8.8° to 20.2° C.; pH 6.8 to 8.2.

Mesocyclops edax (Forbes). Occasional. Primarily in ponds during fall and spring. Water temperature 6.0° to 22.1° C.; pH 6.8 to 9.2.

Cyclops varicans Sars. Occasional. Collected from a small turbid pond, a slough, and a roadside ditch during September and April. Water temperature 9.1° to 18.4° C.; pH 6.8 to 8.0.

Cyclops bicolor Sars. Scarce. Collected from a small pond during September. Water temperature 20.2° C.; pH 8.2.

Cyclops vernalis Fischer. Common. Most frequently collected copepod,

found in all aquatic habitats the year-round. Water temperature 10° to 30° C.; pH 6.8 to 9.3.

Cyclops bicuspidatus Claus. Common. Primarily in ponds, streams and roadside ditches, may occur year-round but most common during fall and spring. Water temperature 4.2° to 20° C.; pH 7.4 to 8.4.

Diaptomidae

Diaptomus oregonensis Lillj. Scarce. Collected from a slough during September. Water temperature 21.7° C.; pH 7.6.

Diaptomus pallidus Herrick. Common. Primarily a year-round inhabitant of ponds. Water temperature 1° to 30° C.; pH 6.8 to 9.4.

Diaptomus clavipes Schacht. Common. Collected mainly from turbid ponds during spring and summer. Water temperature 3° to 27° C.; pH 7.3 to 8.8.

Diaptomus siciloides Lillj. Common. Inhabits all habitats in fall, winter, and spring. Water temperature 5° to 30° C.; pH 6.8 to 9.2.

Diaptomus saltillinus Brewer. Scarce. Reported from a small lake during the fall (Davies 1958). Water temperature 3° to 20° C.; pH 7.4 to 8.0.

Diaptomus sanguineus Forbes. Scare. Reported in a small lake during winter and spring (Davies 1958). Water temperature 1° to 15° C.; pH 7.4 to 7.8.

Canthocamptidae

Canthocamptus robertcokeri M.S. Wilson. Common. Found in ponds, streams, ditches during fall, winter, and spring. Water temperature 5.8° to 21.3° C.; pH 7.4 to 9.3.

DISCUSSION

Thirty-four species of Cladocera representing 5 families were identified from 69 Lyon County habitats (Table 1). All but 5 of these species occurred at least once in samples taken from either turbid cattle ponds or other small, relatively clear impoundments. On the basis of the numbers of species collected from each habitat category, it appears that streams and sloughs were less suitable cladoceran habitats than ponds or roadside ditches. With the exception of *Chydorus sphaericus*, none of the species was frequent in streams. Too few sloughs or roadside ditches were sampled to reveal high frequencies for any species in those habitats. It is possible that continued sampling of ditches and sloughs would show a high frequency for some cladocerans. Also, if each collecting site had been visited a number of times

throughout the year the frequency of some species would have undoubtedly been greater for it is known that some cladocerans occur only during a particular season of the year. A species might be abundant during the fall months but absent or scarce during the summer or winter in the same habitat. Also, one species might vary in relative abundance from one year to the next in the same habitat or from habitat to habitat. Each of the 69 habitats was visited on one of the following dates: September 14, November 7, February 28, and April 15. Thus seasonal variation of species in each habitat was not checked. One other factor that might have influenced the frequency of species is habitat age. Ponds, of course, would provide a more stable habitat than either streams, ditches or sloughs. Habitats which were recently flooded prior to the time a sample was taken might yield a different cladoceran or copepod population than a more mature habitat. Thus the temporary nature of most ditches and sloughs and the intermittency of many of the streams sampled probably account in part for scarcity of species.

As can be seen in Table I, nearly one-half of all samples were from pond habitats. One might have expected, therefore, that the cladocerans from such habitats would have exhibited a greater frequency. However, many of the ponds from which samples were taken were unfenced cattle ponds. Because livestock was able to wade and trample the margins, these ponds were characteristically turbid and practically devoid of both rooted and planktonic vegetation. In such cases Cladocera were relatively scarce and in many cases absent. On the other hand, clear, heavily vegetated ponds were characterized by an abundant cladoceran population.

On the basis of the present study it would appear that *Diaphanosoma brachyurum*, *Daphnia pulex*, *Macrothrix laticornis*, *Bosmina longirostris*, *Alona rectangula*, and *Chydorus sphaericus* are the species most likely to occur in Lyon County. Of the 34 species collected, *Chydorus sphaericus* was the most frequently collected.

Fewer species of Copepoda were encountered; only 18 species representing 3 families were identified from the 69 samples. All but 2 of these species occurred in one or more pond habitats (Table 2). As was the case with the Cladocera, fewer species of Copepoda were collected from streams. Of the 9 species found in stream habitats, only *Eucyclops agilis* appeared frequently.

On the basis of the authors' collections, it appears that *Eucyclops agilis*, *Eucyclops prasinus (Tropocyclops prasinus)*, *Cyclops vernalis*, and *Diaptomus siciloides* are the species most likely to be encountered in Lyon County. In addition to the above 4 species, *Paracyclops fim-*

TABLE 1

List of Cladocera collected in Lyon County showing number of times each species was collected in each type of habitat.

Species	Ponds 33	Streams 21	Ditches 9	Sloughs 6	Total Times Collected
Diaphanosoma brachyurum	9	2	1	3	15
Daphnia pulex	12	2	2	3	19
Daphnia longispina	2	1	1	.	4
Simocephalus exspinosus	1	.	.	1	2
Simocephalus vetulus	3	.	2	1	6
Simocephalus serrulatus	2	.	.	.	2
Scapholeberis mucronata	1	.	1	1	3
Ceriodaphnia rigaudi	2	1	.	.	3
Ceriodaphnia reticulata	2	.	1	.	3
Ceriodaphnia lacustris	1	.	1	1	3
Ceriodaphnia laticaudata	1	.	.	.	1
Ceriodaphnia quadrangula	1	.	1	.	2
Moina macrocopa	.	1	.	.	1
Moina brachiata	3	.	.	1	4
Moina rectirostris	.	.	1	.	1
Bosmina longirostris	7	4	2	1	14
Bosmina coregoni	5	.	1	2	8
Ilyocryptus spinifer	2	.	.	.	2
Macrothrix laticornis	5	4	2	.	11
Kurzia latissima	1	2	.	.	3
Camptocercus rectirostris	1	.	.	.	1
Camptocercus oklahomensis	.	.	1	.	1
Leydigia quadrangularis	1	.	2	1	4
Leydigia acanthocercoides	.	.	1	.	1
Alona guttata	1	2	3	.	6
Alona quadrangularis	.	.	1	.	1
Alona costata	4	1	.	.	5
Alona rectangula	8	5	3	.	16
Pleuroxus striatus	1	.	.	.	1
Pleuroxus hamulatus	2	3	2	1	8
Pleuroxus denticulatus	6	3	1	1	11
Chydorus globosus	1	.	.	.	1
Chydorus gibbus	.	.	1	.	1
Chydorus sphaericus	13	12	5	2	32
Allonella rostrata	1	.	.	.	1

briatus, *Diaptomus pallidus*, and *Diaptomus clavipes* also appeared frequently in samples, and were characteristic of the more turbid ponds.

ADDITIONAL CLADOCERA AND COPEPODA OF LYON COUNTY

The following species were reported from the Lyon County State Lake by Brooks (1947), and to the authors' knowledge they have not since been collected in Lyon County. These species were not included in the annotated list because temperature, pH, and seasonal data were not available.

Sida crystallina (O.F.M.), *Latona setifera* (O.F.M.), *Scapholeberis*

TABLE 2

List of Copepoda collected in Lyon County showing total number of times each species was collected from each type of habitat.

Species	Ponds 33	Streams 21	Ditches 9	Sloughs 6	Total Times Collected
Paracyclops fimbriatus	7	3	3	.	13
Eucyclops agilis	9	10	4	2	25
Eucyclops prasinus	12	4	5	1	22
Macrocyclops ater	.	2	3	.	5
Macrocyclops albidus	1	1	3	1	6
Mesocyclops leuckarti	1	.	1	1	3
Mesocyclops edax	5	1	.	1	7
Cyclops varicans	1	.	1	1	3
Cyclops bicolor	1	.	.	.	1
Cyclops vernalis	15	5	5	6	31
Cyclops bicuspidatus	5	2	3	.	10
Diaptomus oregonensis	.	.	.	1	1
Diaptomus pallidus	8	.	.	2	10
Diaptomus clavipes	9	1	1	2	13
Diaptomus siciloides	17	2	2	4	25
Diaptomus saltillinus	1	.	.	.	1
Diaptomus sanguineus	1	.	.	.	1
Canthocamptus robertcokeri	6	4	5	.	15

aurita (Fischer), *Eurycercus lamellatus* (O.F.M.), *Alona affinis* (Leydig), *Ectocyclops phaleratus* (Koch), and *Orthocyclops modestus* (Herrick).

ADDITIONAL RECORDS OF SPECIES FOR KANSAS

The following species are listed to establish their occurrence in Kansas. No physical-chemical data of their habitats are available. To date none of these species has been collected in Lyon County.

Dunhevedia crassa King. Collected from a small marshy area in Stafford County by Clyde Goulden July 27, 1958.

Latonopsis occidentalis Birge. Collected by Clyde Goulden on July 27, 1958, from a marsh in Stafford County.

Phyllognathopus viguieri (Mrazek). Both males and females were collected from Turkey Creek near Wyandotte County on August 30, 1958. by Clyde Goulden.

Attheyella nordenskioldii (Lilljeborg). var. Collected from a small stream near an artesian well in northeast Stafford County on June 28, 1958. by Paul Jantzen.

SUMMARY

Thirty-four species of Cladocera representing 5 families and 18 species of Copepoda representing 3 families were identified from a total of 69 separate field collections taken from cattle ponds, artificial lakes, streams, roadside ditches, and sloughs in Lyon County from

September, 1958, to April, 1959. *Chydorus sphaericus* was the most abundant and frequently encountered cladoceran; *Cyclops vernalis* was the most frequently collected copepod. Cladocerans were characteristic of clear, heavily vegetated artificial lakes and ponds while copepods, primarily the diaptomid species, were more characteristic of turbid, unfenced cattle ponds. Seven additional species known to occur in Lyon County, but not encountered in field collections during the present study are listed, and 4 species of Cladocera and Copepoda not reported previously in Kansas are included.

LITERATURE CITED

BROOKS, JOHN L. 1957. *The Systematics of North American Daphnia.* Memoirs of the Connecticut Academy of Arts and Sciences, Volume XIII. Yale University Press.

BROOKS, MERLE E. 1947. Crustacea of Lyon County State Lake. Unpublished Masters Thesis. Kansas State Teachers College, Emporia.

DAVIES, H. W. 1958. Winter plankton of a Kansas slough, October 12, 1957, to May 21, 1958. Unpublished Masters Thesis. Kansas State Teachers College, Emporia.

KIEFER, FRIEDRICH. 1931. Die Untergottung Tropocyclops der Gatting Eucyclops (Copepoda, Cyclopoida). Zeitschr. Wiss. Zool., 138: 487–514.

LEONARD, BYRON A., and LUKE H. PONDER. 1949. Crustacea in eastern Kansas. Trans. Kan. Acad. Sci. 52 (2): 168–204.

PENNAK, ROBERT W. 1953. *Fresh-water Invertebrates of the United States.* The Ronald Press Co., New York.

PROPHET, CARL W. 1957. Seasonal variations and abundance of Cladocera and Copepoda and some physical-chemical conditions of the Fall and Verdigris rivers in Wilson and Montgomery Counties, Kansas. The Emporia State Research Studies. 5 (3): 5–29.

————. 1959. A winter population of *Streptocephalus seali* Ryder inhabiting a roadside ditch in Lyon County, Kansas. Trans. Kan. Acad. Sci., 62 (2): 153–161.

RATZLAFF, WILLIS. 7951. The limnology of some roadside ditches in Chase and Lyon Counties, Kansas. The Emporia State Research Studies 1 (1): 5–32.

WILHM, JERRY L. 1955. Seasonal and vertical variations in limnological conditions and abundance of entomostraca in Lake Wooster from October 15, 1954, to April 21, 1955. Unpublished Masters Thesis. The Kansas State Teachers College, Emporia.

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OBSERVATIONS ON THE LIZARDS CNEMIDOPHORUS TIGRIS, CNEMIDOPHORUS TESSELLATUS AND CROTAPHYTUS WISLIZENI

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ABSTRACT. Major range extensions are reported for *Crotaphytus wislizeni* and *Cnemidophorus tigris* in western Texas. Size at maturity, variation and sex ratios are discussed in *Cnemidophorus tessellatus* and *C. tigris*. No males have yet been recorded of *C. tessellatus*, while males outnumber females significantly in samples of *C. tigris*.

Reproduction and micro-evolution in three populations of the desert side-blotched lizard (*Uta stansburiana*) in western Texas are being studied under grant No. G-7143 from the National Science Foundation. The data reported here were obtained simultaneous with, but incidental to, the *Uta* study. I wish to acknowledge my appreciation to the NSF for support. I am grateful to many students of the department of biology of Texas Tech for field assistance and to Dr. William W. Milstead of the University of Kansas City for helpful suggestions and reading the manuscript.

CROTAPHYTUS WISLIZENI WISLIZENI

Brown (1950) records this species from Brewster, El Paso, Hudspeth, and Reeves counties; all west of the Pecos River. The easternmost locality records are from Toyahvale in extreme southern Reeves County. Stebbins (1954) shows the range of this lizard entirely west of the Pecos River.

It is not surprising that collecting in sandy flatlands east of the Pecos River has revealed that the leopard lizard is fairly common there. Thus far it has been found only in association with the lizards *Uta stansburiana stejnegeri* and *Cnemidophorus tigris marmoratus* in areas of fairly loose sand broken only by occasional clumps of scrubby mesquite, creosote brush, catclaw and shinoak. These lizards when approached often take refuge in nests of the pack rat which are abundant throughout the area. The adults first appear in May, rather late compared to other species in the area, and do not become abundant until mid-summer. The young of the year were first seen in early

August, 1959. The presence of the young indicates that this area is within the natural breeding range of this species.

All specimens have been collected 11.5 miles south of Monahans, Ward County, and extend the range about 75 miles to the northeast across the Pecos River.

All specimens are deposited in the collections of Texas Technological College and are numbers (TTC) 911, 974, 1011 (3 specimens), and 1144 (4 specimens). Of the nine specimens available five are females (four adult) and four are males (three adult). The size of adults is fairly uniform, varying in females from 109 to 111 mm. snout-vent and in males from 88 to 93 mm. The femoral pores in the males vary from 20 to 22, but three of the four have 20. The femoral pores of the females vary from 18 to 21, but four of five have 21. These counts are within the normal range of variation in this species.

CNEMIDOPHORUS TESSELLATUS (*sensu* Smith and Burger, 1949)

This lizard appears to have a disjunct distribution in Texas. It has been recorded from most Texas counties west of the Pecos River and in Armstrong and Randall counties of the Texas panhandle by Brown (1950), in Briscoe County by Fouquette and Lindsey (1955) and in Terrell County by Milstead et al (1950). A distance of almost 300 miles separates the southwestern and northwestern populations of this species. The range maps of Stebbins (1954) showing continuous population distribution through the western Texas panhandle appear to be in error. Between the southwestern and northwestern populations there are many habitats in canyons and other broken, rocky terrain that appear suitable for this species, but collecting in this area has not revealed this lizard. Much of this intervening country is populated by *Cnemidophorus tigris* or *Cnemidophorus sacki* and the mutually exclusive ranges of these lizards may have resulted from competition between them.

Specimens of *Cnemidophorus tessellatus* deposited in the collections of the Texas Technological College (TTC) are from the following localities: *Briscoe County*; 15 miles southeast of Silverton (333, 5 spec; 687, 2 spec.); *Randall County*; 12 miles southeast of Canyon (286, 8 spec.; 287, 3 spec.; 721, 4 spec.; 859, 3 spec.; 1064, 20 spec.; 1119; 1200, 2 spec.; 1201, 13 spec.); *Armstrong County*; 25 miles southwest of Claude (157).

The most remarkable aspect of the biology of these lizards is the apparent absence of males in the populations. Minton (1958) reported that all these lizards examined by him from the Big Bend region of Brewster County were females. All individuals in the Texas Tech-

nological Collections are apparently females. Sex is sometimes difficult to determine in very young specimens because the gonads are undifferentiated, but in all juveniles the gonads appeared the same and there were fairly distinct oviducts. This was the basis of sex determination. Of 20 additional specimens examined by a Texas Tech student, Mr. James Peebles, in July, 1959, none was a male.

No explanation is advanced for the absence of males because it is felt that continued collecting of large series from all seasons will reveal the presence of males. In a series of 65 specimens, however, one should expect to find some males, particularly because these specimens are from several different months, so that sampling errors would not seem to account for the absence of males.

Figure 1 shows the distribution of specimens with respect to snout-vent length. All specimens were graphed first but the groupings weren't as sharp as when only spring and fall samples were used. There is a fairly distinct group of juveniles (through 70 mm.), a group of adults above 90 and a few intermediate sized individuals. The smallest sexually mature female (with oviducal eggs) was 86 mm. S-V; the largest immature individual, 70 mm. It is difficult to say whether or not these two size groups also correspond to age groups, so it cannot be stated with certainty whether the lizards reach maturity during their second or third season. It can be seen in the figure that the majority of juveniles in the fall are between 45 mm. and 55 mm. in length. The majority of these have reached 60–70 mm. by the following spring and early summer when there is also present a distinctly larger group of adults, indicating that most individuals will not reach maturity until at least their second spring following birth. The data presented by Fitch (1958) indicate that *Cnemidophorus sexlineatus* in Kansas mature by the end of their second summer.

The femoral pore counts in these lizards are mostly within the range give by Smith (1946) of 19 to 22. One specimen had 18, another 24, but the remainder had 19 to 22. Four had 19, 18 had 20, 31 had 21, and eight had 22. The mean number of femoral pores was 20.7.

Cnemidophorus tigris marmoratus

This name was resurrected by Burger (1950) for the *C. tigris* populations of southern New Mexico and Trans-Pecos Texas. Lizards in the Texas Technological College collections have been compared with the cotypes of *C. t. marmoratus* designated by Burger and found to agree in most details.

Almost all material reported by Brown (1950) was from west of the Pecos River except for records from Ward and Ector counties just

east of the Pecos. Zweifel (1958) in a recent paper says that the range of *C. t. marmoratus* in Texas appears to be confined mainly to the Trans-Pecos region. This species has been found to be extremely abundant in the sand dune areas just east of the Pecos River, and also in the rocky caprock area just below the high plains of northwest Texas. This is an extension of the known range of this species of 125 airline miles to the northwest, and brings the known ranges of *Cnemidophorus tessellatus* and *Cnemidophorus tigris* in northwestern Texas to within 85 miles of one another.

One hundred specimens of *C. tigris* are now available in the collections of Texas Technological College and are from the following localities: *Ward County;* 11.5 miles south of Monahans (511, 2 spec; 807; 909, 4 spec; 1009, 2 spec; 1031, 6 spec; and 116, 4 spec; 40 miles southwest of Odessa (385); *Winkler County;* 6 miles southeast of Kermit (515, 14 spec; 763, 4 spec; 788; 863, 3 spec; 910, 7 spec; 967, 9 spec; 982, 6 spec; 1032, 3 spec; and 1115, 8 spec.). *Garza County;* 10 miles southeast of Post (186, 2 spec; 200; 497, 2 spec; and 504, 4 spec.); 5 miles southeast of Justiceburg (461 and 518, 18 spec.).

There are two striking biological differences between this and the preceding species. One of these is the fact that the sex ratio in *C. t. marmoratus* is more nearly equal with 62 males and 38 females out of 100 examined. Males outnumber females in every month when samples of five or more lizards are available, with the ratios being almost equal in October. The second major difference is that follicles were visible in the ovary of every young *C. tigris* female. The smallest female examined was 48 mm. snout-vent and small follicles were clearly visible. In one specimen of *C. tessellatus* (53 mm. S-V), there were two visible follicles in one of the ovaries and two others 60 mm. had visible follicles. In 29 other juveniles, the gonads were undifferentiated up to a snout-vent length of 73 mm. and in these only the oviducts were distinct enough to make sex identification possible.

In only a few of the specimens was there any trend toward the *C. tessellatus* mesoptychial condition; in most specimens the mesoptychials were clearly separated from the granular throat scales by some scales of intermediate size.

The distribution of the specimens of *C. tigris* with respect to size is shown in Figure 2. The sexes were lumped after a preliminary study showed only small differences in them with respect to size groupings. The largest female examined was 93 mm., and the largest male 92 mm., but the data indicate that adult males average slightly larger than adult females because few females reach a length greater

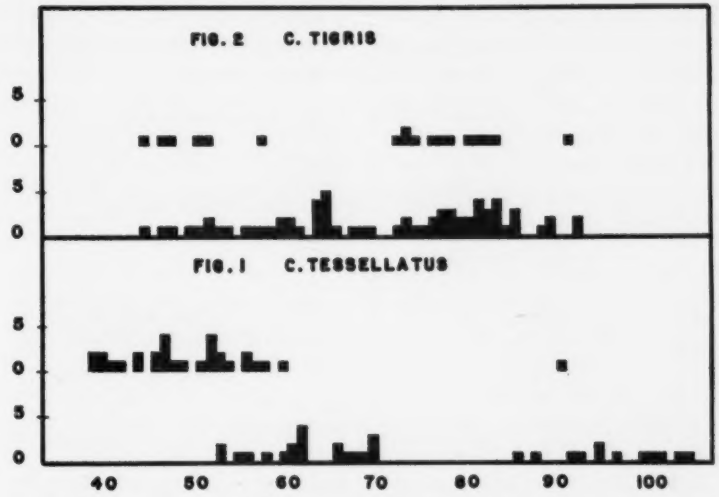

Fig. 1 and 2. Size distribution of specimens of two species of Cnemidophorus. The figures on the abscissa are snout-vent meaurements in millimeters. The figures on the ordinate are numbers of specimens. The top row of specimens in each figure is fall samples (Aug.–Oct.), the bottom row spring samples (Apr.–June).

than 80 mm., while the majority of adult males are longer than that. Neither sex reaches the large size common in *C. tessellatus*.

It is not difficult to discern two major size groups in the data. The data from the fall months are scant, but what is available shows two distinct size groups. These groups are not so distinct in the spring and early summer samples, because growth of individuals in the smaller groups has produced numerous individuals intermediate in size between the two major groups. These data suggest that some individuals may reach maturity in the second summer following their hatching, but many certainly do not. The data obtained by noting the size of the testes and the size and condition of the ovarian follicles indicates that sexual maturity is not reached until the third growing season. The smallest definitely mature male was 74 mm. while the largest definitely immature specimen was 78 mm. Most specimens over 75 mm. are sexually mature. The smallest female containing oviducal eggs was 77 mm. while the largest specimen that was definitely immature was 70 mm. Therefore the size at maturity is about the same in the two sexes and is apparently less in this form than in female *C. tessellatus*.

The femoral pore count is within that typical for the species (Smith,

1946; Zweifel, 1958). Femoral pores in males vary from 19 (1 spec.) to 26 (1 spec.); four have 20, eight have 21, 15 have 22, 17 have 23, 11 have 24 and four have 25. The count in females varies from 20 (4 spec.) to 25 (1 spec.); 10 have 21, 11 have 22, seven have 23 and four have 24. There is very little difference in the femoral pore count of males (mean 22.5) and females (mean 22.0). Most individuals of this form have a count of above 21, while in most *C. tessellatus* the count is 21 or less.

LITERATURE CITED

BROWN, BRYCE C. 1950. *An Annotated Check List of the Reptiles and Amphibians of Texas.* Baylor Univ. Press, Waco, Texas. VII + 257.

STEBBINS, ROBERT C. 1954. *Amphibians and Reptiles of Western North America.* McGraw-Hill Co., N. Y. XI + 528.

BURGER, W. LESLIE. 1950. New, revived and reallocated names for North American whiptailed lizards, genus *Cnemidophorus.* Nat. Hist. Misc. no. 65, 1–9.

FITCH, HENRY S. 1958. Natural history of the six-lined racerunner (*Cnemidophorus sexlineatus*). Bull. Mus. Nat. Hist. Univ. of Kansas 11 (2): 11–62.

FOUQUETTE, M. J., JR., and H. L. LINDSEY, JR. 1955. An ecological survey of reptiles in parts of northwestern Texas. Tex. Jour. Sci. 7 (4): 402–421.

MILSTEAD, WILLIAM W.; JOHN S. MECHAM; and HASKELL McCLINTOCK. 1950. Amphibians and reptiles of the Stockton Plateau in northern Terrell County, Texas. Tex. Jour. Sci. 2 (4): 543–562.

MINTON, SHERMAN A., JR. 1958. Observations on Amphibians and Reptiles of the Big Bend Region of Texas. The Southwest. Nat. 3: 28–54.

SMITH, HOBART M. 1946. *Handbook of Lizards.* Comstock Publ. Co., Ithaca. N. Y. XXI + 557.

SMITH, HOBART M., and W. LESLIE BURGER. 1949. The identity of *Ameiva tessellata* Say. Bull. Chic. Acad. Sci. 8 (13): 277–284.

ZWEIFEL, RICHARD G. 1958. *Cnemidophorus tigris variolosus.* A revived subspecies of whiptail lizard from Mexico. The Southwest. Nat. 3: 94–101.

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THE CHROMOSOME NUMBER OF CHRYSOPSIS PILOSA (COMPOSITAE): A CORRECTION[1]

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ABSTRACT. Chromosome counts of $n = 4$ and $2n = 8$ were obtained from meiotic and mitotic metaphase configurations in plants from 4 populations of *C. pilosa* from central Texas. A previous count for the species had been listed as $n = 5$, but it is apparent that this count was arrived at through a misinterpretation of the diakinesis pairing configurations of an exceptionally large chromosome pair.

Chrysopsis pilosa is an annual weedy species of sandy soils, commonly occurring in abandoned fields and along highways of central and eastern Texas.

Turner (1959) examined the pollen mother cell chromosomes of this species from plants collected in Freestone County, Texas. He reported the chromosome number to be $n = 5$ (3 pair and a ring of 4); however, the camera lucida drawing of the metaphase plate which he published as documentation clearly shows the number to be $n = 4$. The present study was undertaken to determine the nature of the "apparent ring structure" reported by Turner.

Chromosome counts were made from both meiotic material of pollen mother cells and young leaf bud squashes. Flower and leaf buds were collected from plants growing in the field. The young flower buds were placed in a freshly mixed Carnoy's solution (4 parts chloroform: 3 parts absolute alcohol: 1 part glacial acetic acid) and allowed to remain for a period varying from 24 hours to several days. Young anthers were separated from disc flowers and squashed in acetocarmine. Shoots bearing young leaf buds were placed in a saturated solution of 8-oxyquinolene for 2–3 hours, then killed and fixed in a modified Carnoy's solution (3 parts absolute alcohol: 1 part chloroform: 1 part glacial acetic acid). The leaf buds were allowed to stand from 6 hours to several days in the latter solution. Prior to squashing, older leaves surrounding the meristematic tissues were removed; the meristematic tissues were then hydrolyzed in acid alcohol (1 part conc. HCl: 1 part absolute alcohol) for 2–3 minutes, then returned to Carnoy's solution for washing before squashing in aceto-orcein.

[1] I am grateful to Dr. B. L. Turner, Botany Department, University of Texas, for suggesting this study and for his help in the preparation of the manuscript.

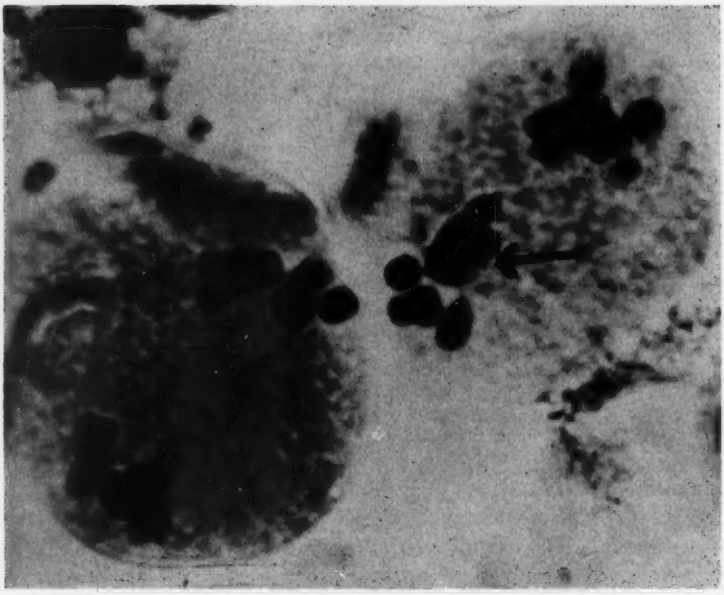

Fig. 1. Photomicrograph of pollen mother cells of *Chrysopsis pilosa* at anaphase I. The arrow indicates the large chromosome referred to in the text. X ca. 2000.

Excellent metaphase and anaphase meiotic configurations were observed (Fig. 1); however, mitotic metaphase chromosomes proved very difficult to count. This was probably due, in part, to the dry condition (poor metabolic state) of the plants from which fresh material was removed for study. Somatic cells of young shoot apices were filled with large crystals and these often obscured the chromosomes in adjacent cells or otherwise prevented sufficient flattening of the cells in attempts to spread the chromosomes. Shoot material taken from relatively young, more vigorous growing plants had fewer crystals and metaphase plates were relatively clear. All efforts to germinate the seeds of *C. pilosa* for root tip counts failed.

Voucher specimens for the collections from which counts were made are listed in Table 1. These are deposited in the University of Texas Herbarium.

Chromosome counts for all the specimens examined proved to be $n = 4$ or $2n = 8$.Ring formation was never observed. Pollen mother cells at late diakinesis showed 3 small bivalents and 1 very large bivalent; because of its size and conspicuous centromere regions, this latter configuration often appeared as a ring of four. Somatic cells from

TABLE 1

Populations of Chrysopsis pilosa sampled for Chromosome Number

Location	Voucher Number	Chromosome Number
Bastrop County: Bastrop State Park, Texas	*Cherry 3*	$n = 4$
Bastrop County: Bastrop, Texas	*Cherry 5*	$2n = 8$
Caldwell County: 2 miles south of McMahan, Texas	*Cherry 2*	$n = 4$
Gonzales County: 4 miles south of Luling, Texas	*Cherry 1*	$n = 4$ (fig. 1)

young shoot meristems also showed 3 pair of small chromosomes and one exceptionally large pair with submedium centromeres.

LITERATURE CITED

TURNER, B. L. 1959. Meiotic chromosome counts for 12 species of Texas Compositae. Brittonia 11: 173–177.

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NOTES

SPECIES OF LAPHAMIA TRANSFERRED TO PERITYLE (COMPOSITAE-HELENIEAE).—From two to six genera were recognized by Gray (1884), Rydberg (1914), Macbride (1918), Everly (1947), and Blake (1951) to accommodate a total of about 50 species of small annuals and perennials typically occurring on canyon walls in desert and semi-desert areas of the southwestern United States and Mexico. Ivan Johnston (1941), in describing a Mexican species which by its lack of pappus technically belonged to *Laphamia*, named it *Perityle Castillonii*, with the observation that there really did not seem to be firm characters by which to distinguish two genera. In Miss Everly's later study (1947), three genera are recognized, distinguished solely by differences in pappus, a very variable structure in the group. She refers to *Laphamia* 19 species having no pappus or only a few awns; to *Pappothrix* 4 species having pappus of numerous awns; and to *Perityle* 25 species having pappus of short scales, usually with 1 or 2 awns in addition. The recently-described *Laphamia staurophylla* Barneby (1957), with pappus of fewer awns than in *Pappothrix* but more numerous than in *Laphamia* as previously known, weakens the lone distinction between the two supposed genera, a distinction that at best was scarcely of generic rank. To uphold *Perityle* as a separate genus solely by the presence of small pappus scales with or without awns (and both structures variable in number and size) seems quite arbitrary. As with the smaller and taxonomically much simpler genera *Chaetopappa* (1946) and *Krigia* (1947), I believe that pappus differences have been greatly overrated, and the many over-all similarities given too little weight. I agree with Ivan Johnston that the recognition of two or more genera is unsatisfactory, and take the logical step of making the necessary transfers to accommodate all accepted species under *Perityle* Betham (1844). Additional information is to be found in the works cited.

PERITYLE **angustifolia** (Gray) Shinners, comb. nov. *Laphamia angustifolia* Gray, Pl. Wright. I (Smithsonian Contrib. III, 5): 100–101. 1852. Incl. var. *laciniata* Torrey, *L. laciniata* (Torrey) Rydberg.

P. **bisetosa** (Torrey) Shinners, comb. nov. *Laphamia bisetosa* Torrey ex Gray, Pl. Wright. II (Smithsonian Contrib. V, 6): 106. 1853.

P. **cernua** (Greene) Shinners, comb. nov. *Laphamia cernua* Greene, Bull. Torr. Bot. Club 25: 122 (with plate 331 f. 3, 4). 1898.

P. **congesta** (M. E. Jones) Shinners, comb. nov. *Laphamia congesta* M. E. Jones, Proc. Calif. Acad. Sci. II, 5: 703. 1895.

P. **fastigiata** (Brandegee) Shinners, comb. nov. *Laphamia fastigiata* Brandegee, Bot. Gaz. 27: 450. 1899.

P. **halimifolia** (Gray) Shinners, comb. nov. *Laphamia halimifolia* Gray, Pl. Wright. I: 100. 1852.

P. **intricata** (Brandegee) Shinners, comb. nov. *Laphamia intricata* Brandegee, Bot. Gaz. 27. 450. 1899.

P. **Lindheimeri** (Gray) Shinners, comb. nov. *Laphamia Lindheimeri* Gray, Pl. Wright. I: 101. 1852.

P. **quinqueflora** (Steyermark) Shinners, comb. nov. *Laphamia quinqueflora* Steyermark, Ann. Mo. Bot. Garden 19: 392–393. 1932.

P. **rotundata** (Rydberg) Shinners, comb. nov. *Laphamia rotundata* Rydberg, N. Amer. Fl. 34 (1): 25. 1914.

P. **rupestris** (Gray) Shinners, comb. nov. *Laphamia rupestris* Gray, Pl. Wright. I: 100. 1852. Incl. *L. cinerea* Gray.)

P. **saxicola** (Eastwood) Shinners, comb. nov. *Laphamia saxicola* Eastwood, Proc. Calif. Acad. Sci. IV, 20: 159. 1931.

P. **staurophylla** (Barneby) Shinners, comb. nov. *Laphamia staurophylla* Barneby, Leafl. West. Bot. 8: 168. 1957.

P. **villosa** (Blake) Shinners, comb. nov. *Laphamia villosa* Blake, Proc. Biol. Soc. Washington 45: 142. 1932.

LITERATURE CITED

BARNEBY, R. C. 1057. A new species of *Laphamia* from New Mexico. Leafl. West. Bot. 8: 168–170.

BENTHAM, GEORGE. 1844–1846. The Botany of the Voyage of H.M.S. Sulphur. (*Perityle*, p. 23, with pl. 15—in Part II, 1844.)

BLAKE, S. F. 1945. Asteraceae described from Mexico and the southwestern United States by M. E. Jones, 1908–1935. Contrib. U. S. Nat. Herb. 29 (2): 117–137. (*Laphamia scopulorum*, 134.)

————. 1951. Compositae, in Kearney & Peebles, Arizona Flora, pp. 829–971. (*Laphamia*, pp. 916–917; *Perityle*, pp. 915–916.)

EVERLY, MARY LOUISE. 1947. A taxonomic study of the genus *Perityle* and allied genera. Contrib. Dudley Herb. 3 (12): 375–396.

GRAY, ASA. 1852. Plantae Wrightianae Texano—Neo-Mexicanae: Parte I. (Smithsonian Contrib. vol. III art. 5.) (*Lamphamia*, Nov. Gen., pp. 99–101.) —Published in March, according to title page.

————. 1886. Synoptical Flora of North America: The Gamopetalae, being a second edition of Vol. I. Part II., and Vol. II. Part I., collected. (*Laphamia*, pp. 319–320; *Perityle*, pp. 320–322—both in Vol. I. Part II.)

JOHNSTON, IVAN M. 1941. New phanerogams from Mexico, IV. Journ. Arnold Arb. 22: 110–124. (*Perityle Castellonii*, pp. 122–124.)

MACBRIDE, J. FRANCIS. 1918. Reclassified or new Compositae, chiefly North American Helenieae. Contrib. Gray Herb. n.s. 56 (V): 36–50. (*Perityle*, pp. 37–39.)

RYDBERG, PER AXEL. 1914. Carduaceae-Helenieae-Peritylanae. N. Amer. Fl. 34 (1): 11–27.

SHINNERS, LLOYD H. 1946. Revision of the genus *Chaetopappa* DC. Wrightia 1: 63–81.

————. 1947. Revision of the genus *Krigia* Schreber. Wrightia 1: 187–206.

STEYERMARK, JULIAN A. 1932. Some new spermatophytes from Texas. Ann. Mo. Bot. Garden 19: 389–395. (*Laphamia quinqueflora*, pp. 392–393.)

TORREY, JOHN. 1852. Appendix D. Botany. In Howard Stansbury, Exploration and Survey of the Valley of the Great Salt Lake of Utah (Senate Document, Special

Session, March, 1851, Executive No. 3), pp. 383–397. (*Monothrix*, nov. gen., pp. 398–390.)—Letters of transmittal on p. 2 are dated April 19, 1852. It is evident from the contents that only a delay in printing prevented *Monothrix* from having legal priority over *Laphamia*, and only by a few weeks.—*Lloyd H. Shinners, Herbarium, Southern Methodist University, Dallas 5, Texas.*

A STUDY OF LEAF VARIABILITY IN THE WATER OAK, *QUERCUS NIGRA* L.—For a period of five years the author made observations of 17 mature water oak trees and associated saplings and seedlings growing in the Oakwood section of Houston, Texas. The trees, with trunk diameters ranging from two to nearly three feet were growing on high, well drained ground. In this relatively dry situation the nature of early and late leaves appeared to be affected more by recurrent drouths than the leaves of trees growing in wetter habitats elsewhere in the vicinity.

SEEDLINGS. The first few nodes of seedlings produce only slender stipules and dormant buds. The first leaf is entire and widest at the crown, the second similar, but narrower and with a few small teeth, and the third leaf is oblanceolate, with three or more acute aristate lobes. Subsequent seedling leaves are of the latter form.

MATURE TREES. The mature spring leaves of the water oak have two characters which set them apart from all other Texas oaks,—the broad apex and tapered base, and the presence of only three to five primary veins which form a narrow angle with the midrib. Late season leaves are oblanceolate and have three or more acute aristate lobes.

The incompletely trilobed cuneate leaves, the type on which Linneaus based the species, are fairly common. These have the entire cuneate base and the broad apex of the spring leaves, but the center of the apex or crown is extended and divided into three small rounded or acute lobes. Diamond and kite-shaped leaves are sometimes present. On determinate branches, the internodes remain short and rosettes on leaves are formed.

Trees with trilobed leaves, the variety *tridentifera* of Sargent, constitute an easily recognizable group. The lobes are distinctive and so also is the general shape of the leaf. The basic leaf structure of the species, with broad apex and narrowed base, is maintained but expressed differently. The broad upper part is separated from the base by an abrupt constriction at or near its middle, emphasizing the contrast in the shape of the two parts.

The leaves of the typical water oak taper evenly from base to tip. In var. *tridentifera* the leaf bases vary from acute to broadly rounded and are often abruptly swollen and arrowhead-shaped below the wide and deep sinuses. The leaves with acute bases have similar variations in both the upper and lower parts. The lobes may be short, with the apical lobes not more than twice the length of the lateral lobes or, in late season leaves, the apical lobe may be very long. In the latter case there are only two lateral lobes and these are opposite each other. The leaf thus roughly has the shape of a cross and has been referred to as cruciform.

HYBRIDS. All suspected hybrids seen at the Houston location appeared to be crosses between the typical variety of *Q. nigra* or its variety *tridentifera*, and *Q. phellos*, the willow oak. In the study area the latter species has but one standard leaf form. The blades are narrowly elliptic, at least five times as long as broad and acute at the tips of crown and base. The midrib is somewhat raised, slightly more so on the underside than above. The primary veins are numerous, with mostly 10 to 20 on each side, and form a wide angle with the midnerve. The late season leaves show no change in form.

The occurrence of leaves typical of both *Q. nigra* and *Q phellos* on the same branch was noted in a seedling, a sapling, and a tree eight inches in diameter. This led to a search for plants with intermediate leaves. Such plants were soon found, and these could be separated into two groups.

In the first group of plants, leaves typical of *Q. nigra* were of the obovate, cuneate and spatulate types. Some of the leaves had the *Q. phellos* shape but showed the veining of the *Q. nigra* leaf, the only strong character of the latter species exhibited. Only a few of these plants were seen. They are apparently of hybrid origin.

In the second group, characters of *Q. nigra* var. *tridentifera* appear. Leaf lobes, small or large, signify the influence of this taxon. The group of suspected hybrid plants included trees with both trilobed and tridentate leaves. Where *Q. nigra* was represented by the merely trilobed leaves, some of the hybrid types had leaves with rounded lobes at their tips. This type merged into that in which tridentate leaves were more common. In some specimens the leaf was elongate and acute, the lateral lobes short and acute and forming symmetrical pairs near the base of the leaf or near the tip of the terminal lobe.

In an interesting form that was met with infrequently the leaf had four or more short narrow lobes in matched pairs, forming a cross with two bars. One specimen with a few typical leaves of *Q. phellos* had leaves with three long, acute lobes shaped like large segments of *Q. phellos* leaves. Even in this case where the lobes were largest, the *Q. phellos* characters dominated.. All these intermediate leaves were on trees more typical of the variety *tridentifera*, never on those of *Q. phellos.—Ernest C. Cmith, Honorary Research Associate, Tracy Herbarium, A. & M. College, College Station, Texas.*[1]

LIATRIS TENUIS N. SP. (COMPOSITAE), ANOTHER ENDEMIC IN SOUTHEASTERN TEXAS.—In a genus confined to the United States (except for a single species extending slightly into Mexico) and intensively monographed as late as 1946 (Gaiser, L. O., "The genus *Liatris*," RHODORA 48: 165–183, 216–263, 273–326, 331–382, 393–412), an undescribed, well-marked species is not to be expected. Five collections (the earliest, it may be noted, collected while Dr. Gaiser's revision was in press) from four counties in southeastern Texas belong to a distinct new species whose salient features unfortunately cut across the key characters for the sections and series of the genus recognized by Miss Gaiser (l.c., pp. 176–177). The plants suggest a very slender form of *L. glabrata* Rydb. var. *alabamensis* (Alexander) Shinners (Field & Lab. 19: 76, 1951), but lack plumose pappus and must be excluded from the whole group of *L. glabrata* (included by Gaiser in *L. squarrosa*). In her key, they run directly to Series Pycnostachyae, whose single species, *L. pycnostachya*, they do not resemble. The only possible alternative Series, the Southeastern (South Carolina to Florida and Alabama) Tenuifoliae, with small heads (3–6-flowered) having obtuse to acute, more or less appressed phyllaries,

[1] This paper was edited and forwarded for publication by Dr. F. W. Gould who states: "These interesting notes are presented by a man 95 years of age. Mr. Smith received his first college degree at Bowdoin College, Brunswick, in 1884. After two years at the Harvard University Divinity School be became a Unitarian Minister and served in this capacity for 43 years. Upon retirement at the age of 65, he moved to Colorado and became affiliated with the Colorado Agricultural College (Colorado State University), first as a student and then as an instructor of plant taxonomy and Curator of the Herbarium. His principal taxonomic interests were with the Salicaceae and the myxomycetes. His second retirement came at the age of 76, but his interest and activity in taxonomy has continued to the present. Mr. Smith now resides in Houston, living with his granddaughter and grandson-in-law, and his three great-granddaughters."

hardly accommodates our plants with their larger heads (10–11-flowered) having conspicuously acuminate phyllaries with wide-spreading tips. Two endemic species of *Liatris* are already known from south-central Texas: *L. bracteata* Gaiser (Brazos, Fort Bend, Galveston, Harris, Karnes, Live Oak, and Matagorda counties), nearly related to two species (*L. mucronata* and *L. punctata*) common and widespread farther west and north; and *L. cymosa* (H. Ness) K. Schum. (Brazos and Washington counties), whose nearest relative is a similarly restricted Florida species. The new endemic here described, while resembling groups that are primarily Southeastern, cannot at present be definitely associated with any one species or Series as defined by Gaiser.

LIATRIS **tenuis** Shinners, sp. nov. Planta quasi *L. glabrata* gracillima, vel *L. secunda* capitulis paucioribus majoribus non secundis. Cormus parvus (10–21 mm. diam.) globosus vel obnapiformis. Caules solitarii vel pauci ca. 30–55 cm. longi erecti vel subarcuati, basin versus hirtelli pilis patentibus vel adscendentibus, superne strigillosi. Folia sat crebra linearia puncticulata plus minusve marginibus et secus nervum unicum pilosula acuta, caulina infima ad 15 cm. longa et 4.2 mm. lata, mediocria abrupte multo minora, suprema in bracteas 1–3 cm. longas et 1.0–1.5 mm. latas reducta. Inflorescentia ca. 15–25 cm. longa gracilis interrupte spicato-racemosa. Capitula erecta solitaria et interdum subgeminata plerumque inter sese internodis 7–15 mm. longis distantia, subsessilia vel breviter pedunculata (pedunculi usque 3 mm. longi). Involucra cylindrico-campanulata 10–13 mm. longa. Phyllaria ca. 4–5-seriata anguste ovata acuminata apicibus attenuatis patentibus vel subrecurvatis ciliata dorso glabra vel infima pilosula. Flores 10–11. Corolla ca. 7 mm. longa. Pappi seti barbellulati 4–7 mm. ongi. Achaenia 4.2–4.5 mm. longa secus costas prominentes pilosula. HOLOTYPE: open pine woods, sandy loam, 9.2 miles south of Bronson, Sabine Co., Texas, *Shinners 26,600*, 3 August 1957 (SMU). "Corollas deep rosy lavender." Additional collections, all from southeastern Texas and all in Herb. Southern Methodist University: ANGELINA Co.: near "Blue Hole," *D. S. & H. B. Correll 12,560*, June 10, 1946. JASPER CO.: 11.6 miles north of Jasper, cleared fencerow, red sandy clay with thin cover of loose gray sand, *Shinners 24,242*, 29 July 1956. SABINE CO. (incorrectly labelled as from Jasper Co.): 7⅓ miles south of Bronson, frequent on roadside, *V. L. Cory 56547*, July 7, 1949. TYLER CO.: 6¼ miles north of Colmesneil, frequent along small drainage courses in cut-over pine woods, *Cory 56720*, July 10, 1949.

The two collections obtained by myself (including the holotype) were made in the course of field work subsidized by the National Science Foundation, to whom grateful acknowledgment is made.—*Lloyd H. Shinners, Herbarium, Southern Methodist University, Dallas 5, Texas.*

SPECIES OF BERENDTIA GRAY (SCROPHULARIACEAE: NOT GOEPPERT, FOSSIL MYRSINACEAE) TRANSFERRED TO BERENDTIELLA.—In the Gesamtregister zum II.–IV. Teil of Engler & Prantl's Die Natürlichen Pflanzenfamilien, p. 459, 1899, note is made of the fact that the fossil genus *Berendtia* Goeppert (summarized in the same work, Teil IV, 1: 97, 1897) was published in 1845, antedating *Berendtia* Gray, Proc. Amer. Acad. 7 (1867): 379–380, footnote (issued 1868). For the later homonym published by Gray, *Berendtiella* Wettstein & Harms is proposed as substitute, but no transfers are made to supply binomials for the species. These are:

BERENDTIELLA **coulteri** (Gray) Shinners, comb. nov. *Berendtia Coulteri* Gray, Proc. Amer. Acad. 7: 380. 1868. According to Hemsley (in Salvin & Godman,

Biol. Centr.-Am. Botany 2: 448, 1882), this occurs in "South Mexico, Zimapan and San Blas to Guadalajara."

B. **levigata** (Robinson & Greenman) Shinners, comb. nov. *Berendtia levigata* Robinson & Greenman, Proc. Amer. Acad. 32: 39. 1896. (Repr. as Contrib. Gray Herb. 10.) Puebla.

B. **rugosa** (Bentham) Shinners, comb. nov. *Diplacus rugosus* Bentham in DC., Prodr. 10: 368. 1846. *Berendtia rugosa* Bentham ex Gray, l.c. According to Hemsley, *Berendtia Ghiesbreghtiana* Gray (as "*Ghiesbrechtiana*," l.c. p. 380), which form its double eponymy may be considered the type species of the genus, is a synonym of this. Chiapas.

B. **spinulosa** (S. Watson) Shinners, comb. nov. *Berendtia spinulosa* S. Wats., Proc. Amer. Acad. 25: 159. 1890. Nuevo Leon.

Both Gray and Wettstein (in Engler & Prantl, l.c. Teil IV, 3b: 67, 1895) place the genus in the tribe Cheloneae, though it superficially resembles *Diplacus (Mimulus)* in the Gratioleae.—*Lloyd H. Shinners, Herbarium, Southern Methodist University, Dallas 5, Texas.*

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REVIEWS

CIRCUMPOLAR ARCTIC FLORA. Nicholas Polunin. xxviii + 514. Illustrated. Oxford University Press, Oxford, England. $20.20.

Dr. Polunin's *Circumpolar Arctic Flora* is the first volume of a projected series of four books dealing with the plants of the arctic. As might be expected, the first volume is the taxonomic treatment. Dr. Polunin clearly states the limitations of the flora in the introduction by writing that it is " 'non-critical' in that it gives no account of taxa below the rank of species, though it does attempt to cover such variants within the orbit of specific descriptions." If this is recognized by the user, the book should prove most useful. The arctic is defined in this volume as all the land 50 miles north of the taiga, north of the limit of microphanerophytic growth, or north of Nordenskiöld's line. The arctic is subdivided into ten sectors as follows: western European, northeastern European-northwestern Asian, western-central Siberian, eastern-central Siberian, easternmost Siberian, Alaska-Yukon, Canadian western arctic, Canadian eastern arctic, west Greenland, and east Greenland. The geographical range of species is given with reference to these sectors.

Dr. Polunin recognizes 66 families, 230 genera, and 892 species of vascular plants in the arctic. The treatment of the species is conservative. For instance, such species as *Astragalus umbellatus*, *Oxytropis viscida*, and *Hippuris tetraphylla* are not treated as species but rather are grouped with *A. frigidus*, *O. leucantha*, and *H. vulgaris* respectively. No mention is made of *Youngia americana*, a species of the Alaska-Yukon sector of the arctic. By his conservative treatment of species, the author has avoided many taxonomic problems and has left them to others. Short diagnoses of families, genera, and species are included, but they are not always uniform. The treatment of a particular genus varies depending upon the number of species it contains. A genus with nine or more of its species in the arctic has a lengthy detailed bracketed key. The key contains short diagnoses of the species. Those genera with less than nine species do not have keys but have diagnoses after the names of the species. No explanation is given as to why nine is the magic number. To this reviewer, a more uniform arrangement of the material would have been preferable. Generic keys are included, as is a key to the families, but the latter is often polychotomous. Certain evasive terms appear in the text. The Haloragaceae are described as being "A smallish family of dicotyledonous herbs . . . ," *Cerastium* is "A largish genus . . ." and *Polygonum bistorta* is "an erect and smoothish perennial . . ." Standardized herbarium abbreviations are not used, but instead one finds such lengthy designations as Herb. Arnold Arboretum and Herb. British Museum.

The format of the book is pleasing and the text except for the introduction is in two columns per page. Each species is illustrated with a line drawing and on the whole, the illustrations are excellent. *Circumpolar Arctic Flora* will be a valuable and useful reference to anyone interested in the plants of the arctic or of temperate regions. But anyone using it must very carefully read the introduction in order to understand the limitations of the book. *John H. Thomas, Dudley Herbarium, Stanford University, Stanford, California.*

ERRATA

Volume 3, p. 105 (In Some Observations on Texas Cave Bats by Gerald G. Raun and James K. Baker) line 27 should read *Pipistrellus subflavus* instead of "*Pipistrellus hesperus.*"

PUBLICATION DATES OF THE SOUTHWESTERN NATURALIST

The following are official publication dates for the *Southwestern Naturalist* through volume four. Beginning with volume 4, number 2, the date shown on the cover is the date of publication unless otherwise specified in future issues of the journal.

Volume 1, no. 1. June 4, 1956.
Volume 1, no. 2. Jan. 22, 1957.
Volume 1, no. 3. Aug. 27, 1957.
Volume 1, no. 4. Jan. 13, 1958.
Volume 2, no. 1. Oct. 15, 1957
Volume 2, no. 2–3. Dec. 27, 1957.
Volume 2, no. 4. June 10, 1958.
Volume 3, nos. 1–4. May 29, 1959.
Volume 4, no. 1. July 22, 1959.
Volume 4, no. 2. September 15, 1959.
Volume 4, no. 3. October 24, 1959.
Volume 4, no. 4. December 15, 1959.

INFORMATION FOR CONTRIBUTORS

THE SOUTHWESTERN NATURALIST is open to papers dealing largely or exclusively with the natural history of the Southwestern United States and Mexico. Articles or notes in English or Spanish on the taxonomy, geography, ecology, and evolution of living or fossil organisms of the region are acceptable, as are bibliographical, historical and biographical articles which contribute to investigations in these fields. Priority is given to manuscripts submitted by members of the Association.

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